Habitat assessment of the area of the Cardigan Bay SAC proposed for a fishing intensity experiment

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Contents

Introduction 2
1 - Description of the area proposed for the experiment 4
2 - Existing seabed maps 5
3 - Video and still images surveys 8
4 - Side scan surveys 12
5 - Additional information 44
6 - Experimental design 45
Discussion 49
References 50

Introduction

The Fisheries and Conservation Science Group of Bangor University is proposing to run an experiment in the Cardigan Bay SAC, as part of their EFF project. The work aims at determining thresholds of scallop fishing impact on the seabed in order to advise the Welsh Government on possible sustainable options for the scallop fishery in an ecosystem approach framework. The proposed location of the experiment is on a previously exploited scallop bed that has been closed to fishing activities for 5 years.

Cardigan Bay was originally selected as an SAC primarily to protect the resident bottlenose dolphin population (*Tursiops truncates*). Seabed habitats, i.e. stony reefs, were not the primary focus of the designation but were included as quality features of the designated site. Therefore, following previous advice from CCW to the Welsh Government, the area proposed for the fishing experiment lies between 3 and 12nm, avoiding any potential adverse effects between dolphin prey/dolphin habitat and scallop gear interactions within 3nm. Furthermore, in order to conduct the fishing experiment proposed within the EFF project, an appropriate assessment has to be conducted to provide evidence of the absence of stony reefs in the area of the SAC that would be impacted by fishing gears during the experiment.

In 2008, JNCC held a workshop with experts of the UK's Statutory Nature Conservation Bodies (SNCBs) to define the term 'stony reef' in practical terms to aid in the classification of these habitats. The stated aim was to 'clarify the definition of 'stony reef' under the Habitats Directive and to help with recognizing those areas of the seabed that can be classed as stony reef, and those areas that would fall outside this definition' (Irving 2009). The results of this workshop were summarized in a report in 2009 (Irving 2009) and represent the most recent unified view of the SNCBs.

Several abiotic and biotic parameters were evaluated as descriptors that could be used for the classification of 'stony reefs' and four of these were felt most practical in deciding if a habitat comprised a 'stony reef' or not. These were: composition (referring to the sediment type), elevation, extent and biota (see Table 1). Each characteristic was given a four point grading from not representing a reef to high 'reefiness' (see Table 1).

It should be noted that the most important overarching criteria is the composition of the sediment, in other words the percentage of stones present at a site to qualify as a stony reef (10% of stones have to be larger than 64 mm for a habitat to be considered as reef like, see Table 1). This is therefore the main focus of the present report, which gathers extensive available evidence on the seabed composition of the potential experimental area. Extent and elevation were also looked at to the extent possible and wherever relevant. However, biota was judged to be a qualitative indicator of conservation value by the JNCC report but no clear criteria with respect to biota was set other than the dominance of epibenthic species as opposed to infaunal species (Table 1). As the past surveys did not assess infaunal benthic communities in the area of interest, this aspect of the 'reefiness' criteria was not explored, although some information on epifauna is presented. Details of the proposed experiment are described at the end of the report.

Table 1. Summary of the main characterising features of a stony reef as outlined by the JNCC report (Irving 2009).

Characteristic	Gp	Not a 'stony reef'	'Reefiness' Low	Medium	High
Composition					
	1	<64mm	Matrix- supported		Clast- supported
	2	Not suggested	Not suggested		
Boulders / cobbles (>64mm)	3	<10%	10-40% Matrix- supported	40-95%	>95% Clast- supported
Consensus:		**<10%**	**10-40% Matrix supported**	**40-95%**	**>95% Clast supported**
Elevation					
	1	Flat, featureless seabed	<64mm	64mm-5m	>5m
(Topographical distinctiveness)	2	Must be an identifiable feature distinct from the surrounding seabed (could use MESH definition as a standard here)			
	3	<0.05m	0.05-0.30m	0.30m-5m	>5m
Consensus:		**Flat or undulating seabed**	**<64mm**	**64mm-5m**	**>5m**
Extent					
	1	Not suggested	Not suggested		
	2	<5m x 5m	← $>25m^2$ →		
Total Area	3	$<25m^2$	$25m^2$-$1km^2$	1-$10km^2$	$>10km^2$
Consensus:		**$<25m^2$**	**← $>25m^2$ →**		
Biota [B]					
Ecosystem function	1	Dominated by infauna	Use SACFOR scale		>80% epifauna
Biological component	2		Should be biased towards physical aspects with less emphasis on biology. Should be characteristic of biogeographic region		
Function	3	Impossible to quantify			
Consensus:		**Dominated by infauna**			**>80% epifauna**
Patchiness					
(100% cover of 1m x 5m) [A]	1		1m x 50m area Clast-supported 20% cover of 1m x 5m patches	↔	1m x 50m area Matrix-supported 60% cover of 1m x 5m patches
% cover of hard substrata (>64mm constituent) within 'reef'	2		>50% coverage by hard substrata, but at least 25% (of the 100%) needs to be cobble-sized or larger if smaller sediments are present.		
($100m^2$ *or* 100m x 1m transect) [A]	3	<10%	10-50%	50-75%	>75%
Consensus:		**<10%**	**10-50%**	**50-75%**	**>75%**
Stability [B]					
	1	Not stable enough to support epifauna	Could support encrusting epifauna	↔	Able to support erect epifauna
	3	Did not think that the size of physical constituents could be quantified, or the composition of the biota			
Distinctness	3	Impossible to quantify			
Sub-seabed structure	3	Group was not able to progress this further due to lack of time			

Notes:

A	**1m wide areas suggested here as 1m approximates to the width of the seabed viewed by video.**
B	**The term 'Biota' was not given as a category to be considered by the separate break-out groups. However, each group came up with their own title which, on reflection, appear very similar & are therefore grouped together.**

1 - Description of the area proposed for the experiment

The area proposed for the experiment is approximately 110km^2 (ca. one ninth of the total Cardigan Bay SAC area, which is ca. 960km^2). Part of it will be impacted by fishing gear while the rest will be used as control areas, i.e. non-impacted areas to which impacted areas could be compared to monitor direct impact as well as long term recovery. The details of the proposed experiment are explained in the last section of the present report (section 6). Figure 1 shows the proposed area where the experiment would take place.

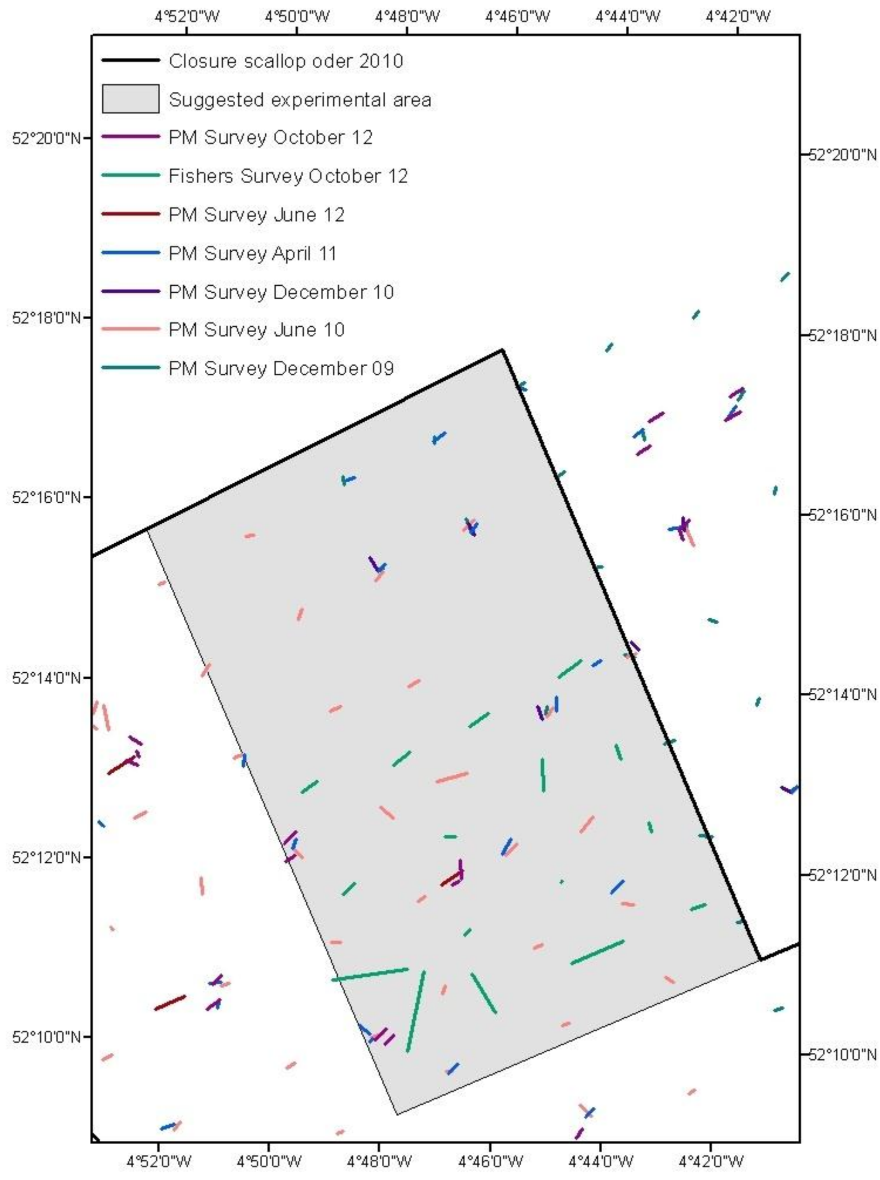


Figure 2. Proposed experimental area and location of video tows which have been conducted with the Prince Madog (PM) by the School of Ocean Sciences, Bangor University, and individual fishermen between 2009 and 2012, in the Cardigan Bay SAC.

2 - Existing seabed maps

In an effort to gather all the existing evidence, seabed maps of various sources were collected. Figures 2, 3 and 4 present maps of the Cardigan Bay SAC, with focus on the experimental area. Of those 3 maps of various sources, none of them suggest the likely existence of reefs in the proposed experimental area.

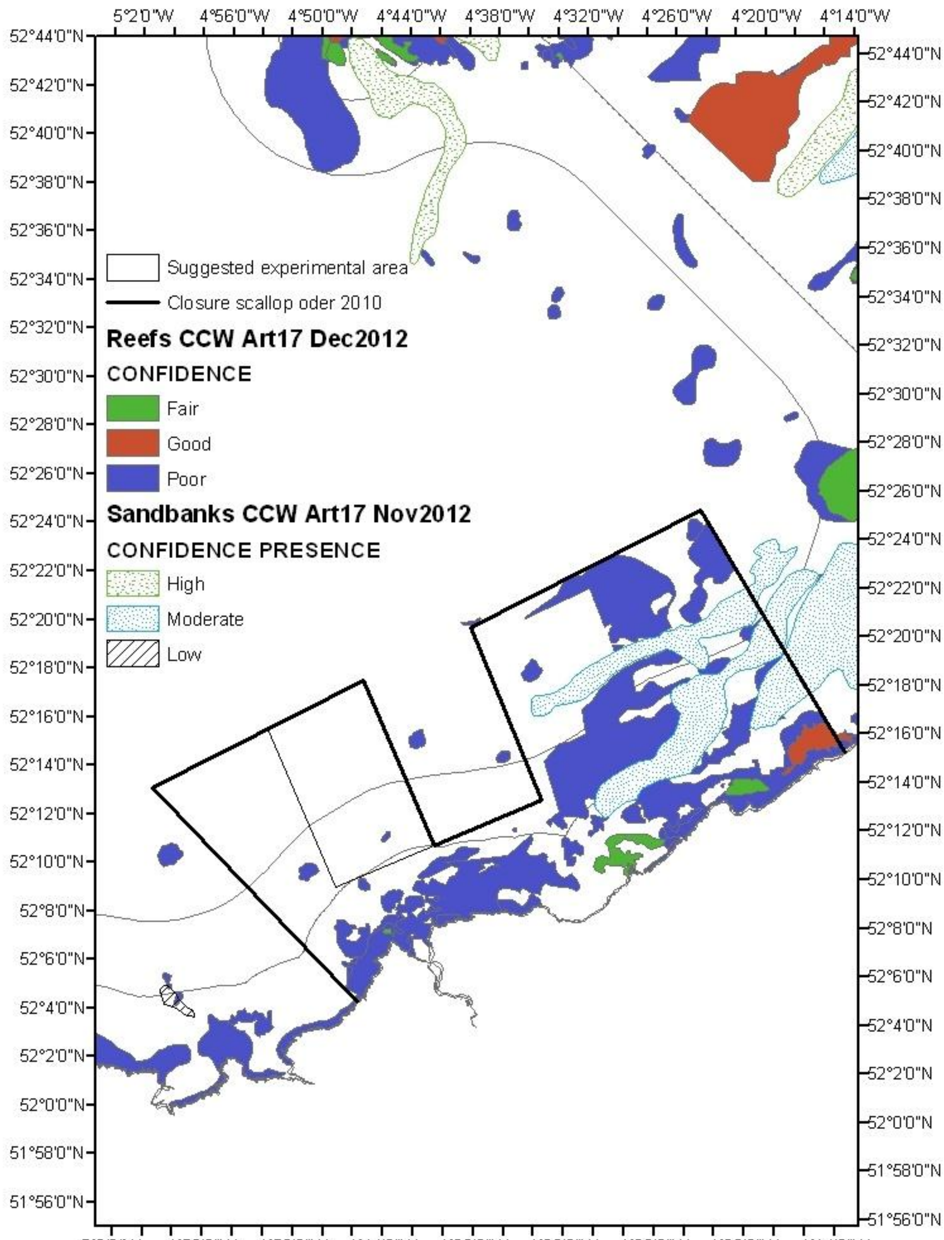


Figure 2. Subtidal reefs and sandbanks of the Cardigan Bay SAC (*contains Natural Resources Wales information © Natural Resources Wales and database right*).

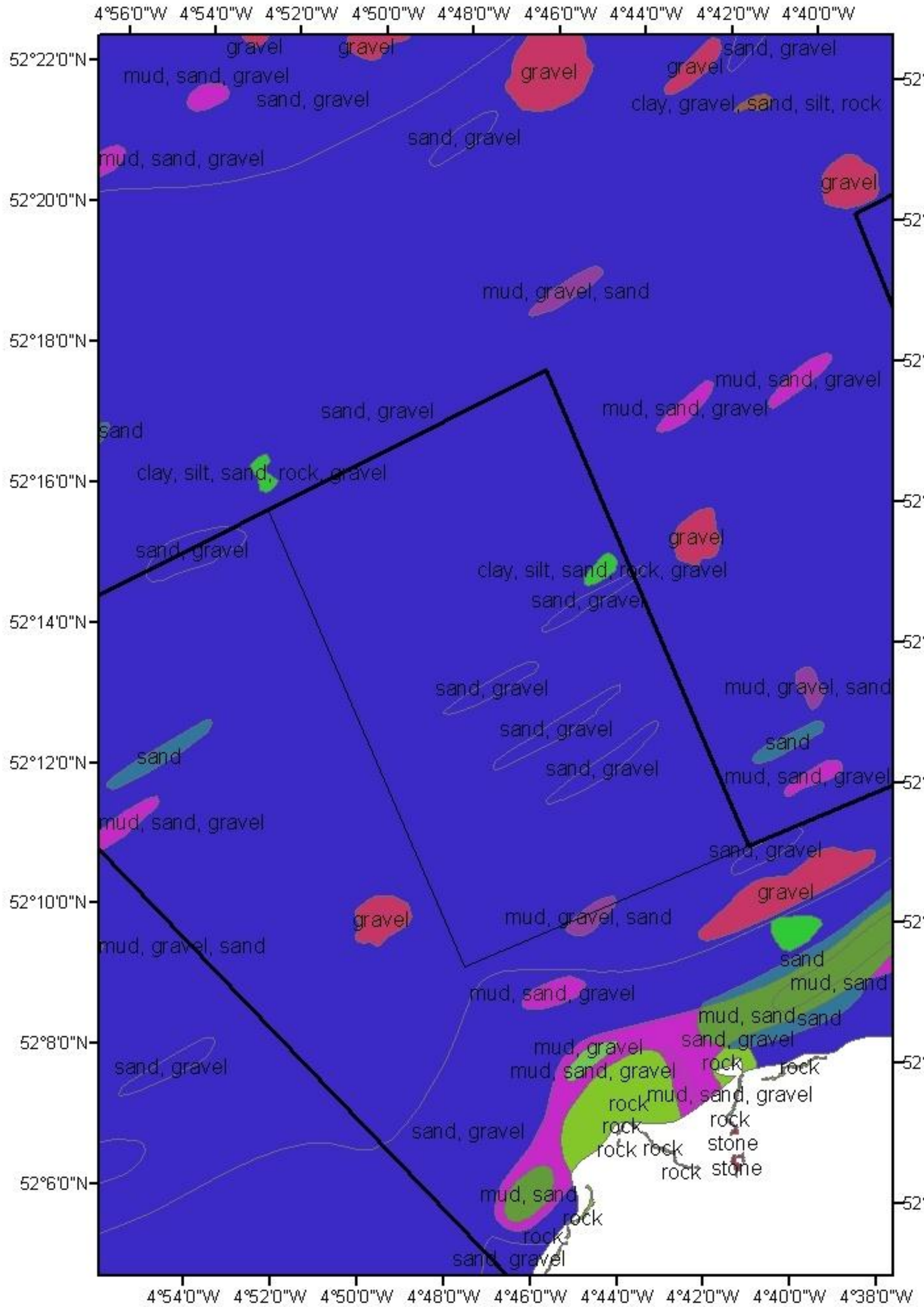


Figure 3. Map of sediment types in the suggested experimental area (*source Edina Digimap*)

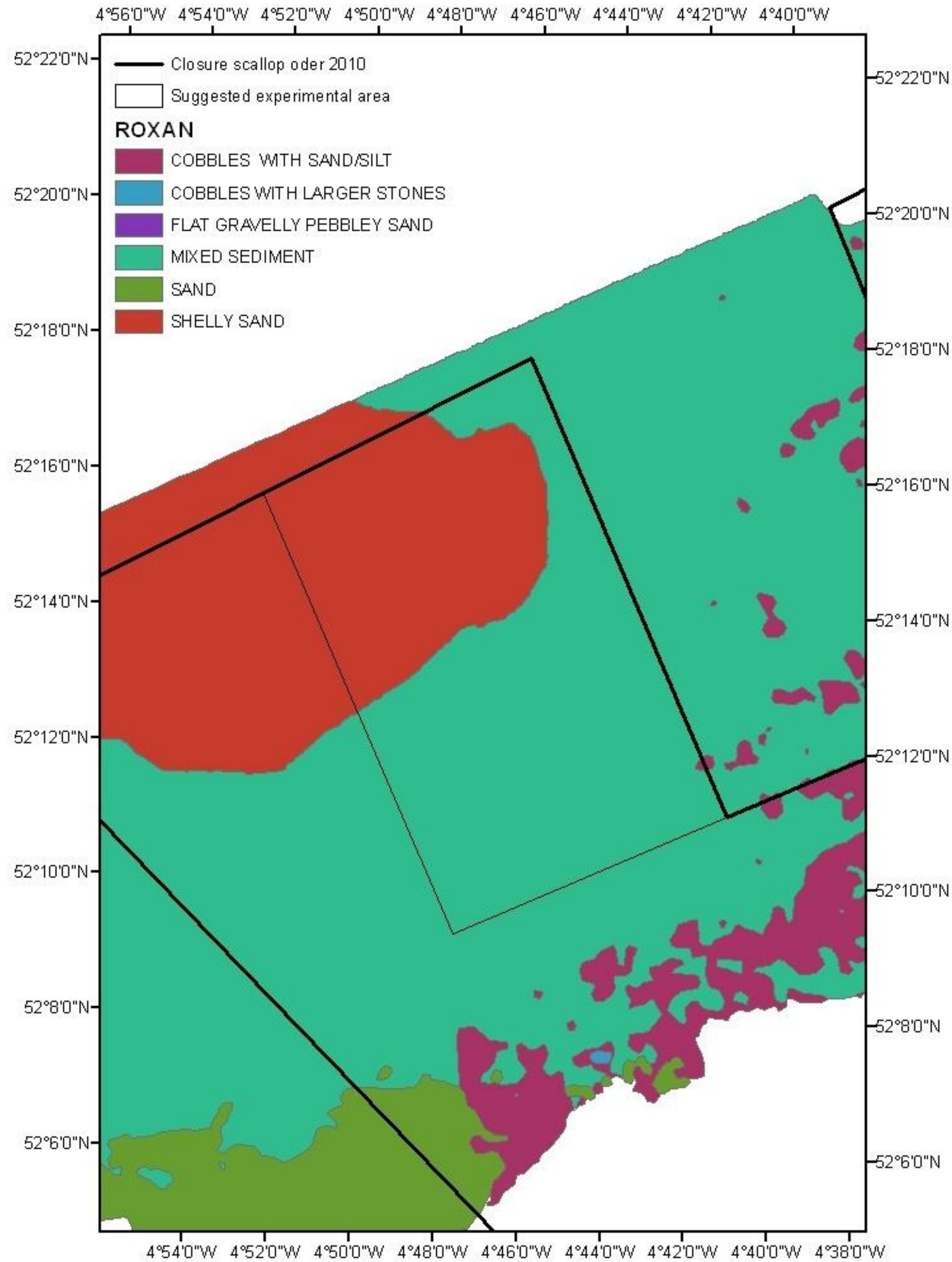


Figure 4. ROXAN map of the proposed experimental area (*source unknown*)

3 - Video and still images surveys

Numerous video and stills surveys conducted by Bangor University have taken place in the Cardigan Bay SAC since 2009 during 3 consecutive years: December 2009, June 2010, October 2010 and April 2011. Additionally, 2 surveys have been conducted as part of the EFF project of Bangor University in June 2012 and October 2012. Most of the sites surveyed were the same year after year, in an effort to monitor habitat recovery in the protected area compared to the area remaining open to fishing. However, fishermen started collecting their own data and Len Walters, fisherman from Cardigan Bay, conducted a detailed survey of the proposed experimental area in October 2012, targeting sites which had not previously been surveyed by Bangor University and the EFF project team. All the sites surveyed are mapped in Figure 5, for a total of 68 data points.

The surveys conducted by Bangor University and the EFF team were conducted onboard the RV Prince Madog. A sledge mounted video and stills camera system was deployed at each sampling station and towed at a speed of approximately 0.5 knots for a period of 10 to 15 minutes. Start and end positions of each tow were recorded from the point the sledge had visibly reached the sea floor to the point when the sledge lifted off the ground during hauling. While the video system delivered a continuous live picture which was recorded on DVD, the digital stills camera took a high resolution image every 9 or 10 seconds. Each still image covered an area of $0.13m^2$ (0.44m x 0.30m). A different system was used to film the seabed from the fishing vessel. A mini-sled was designed to be towed from a small scalloping or potting vessel. A GoPro video camera was fitted at an angle of approximately 30 degrees to the seabed and the sled was towed for about 15-20minutes at low speed (<1kn). The video frame covered an area of approximately $0.5m^2$.

Pictures from the sites surveyed by Bangor University and the EFF team and videos from the sites surveyed by the fishers (tows shown in Figure 1) were analysed for substratum type (Figure 5). Since the videos and pictures had initially been collected and analysed by different scientists and for different objectives, they were all reanalysed using a consistent methodology for the purpose of the present report, using the software CPCe. This software was initially developed for coral reef analyses. It allows the distribution of random points on an image and the categorisation of the sediment by attributing a category to each point. It then reports the sediment type percentages in an Excel format. On average between 10 and 30 pictures or video frames were analysed at each site, depending on the apparent heterogeneity of the substratum along the tow. The classification used followed the Wentworth scale (Table 2). Since the videos could not allow the distinction between anything smaller than 2mm, only 5 categories were used (fine particles (<2mm), gravel (2-4mm), pebble (6-64mm), cobble (64-253mm), and boulders/bedrock (>253mm). The objective of the research being to find out whether cobble reefs existed in the area, this classification was deemed appropriate.

Table 2. Udden-Wentworth Grain-Size Classification Scheme (Wentworth, 1922)

Millimeters (mm)		Micrometers (µm)	Phi (φ)	Wentworth size class		Rock type
	4096		-12.0	Boulder	Gravel	Conglomerate/ Breccia
	256		-8.0	Cobble		
	64		-6.0	Pebble		
	4		-2.0	Granule		
	2.00		-1.0	Very coarse sand	Sand	Sandstone
	1.00		0.0	Coarse sand		
1/2	0.50	500	1.0	Medium sand		
1/4	0.25	250	2.0	Fine sand		
1/8	0.125	125	3.0	Very fine sand		
1/16	0.0625	63	4.0	Coarse silt	Silt	Siltstone
1/32	0.031	31	5.0	Medium silt		
1/64	0.0156	15.6	6.0	Fine silt		
1/128	0.0078	7.8	7.0	Very fine silt		
1/256	0.0039	3.9	8.0	Clay	Mud	Claystone
	0.00006	0.06	14.0			

Figure 5 shows the sediment composition at each of the sampled sites. Overall, the proposed experimental area appears mostly shelly in the north with a trend towards increased percentages of pebbles and gravel in the south west corner. This reflects well the Roxan map presented Figure 4. Mixed substratum types are found in the south east area with presence of brittlestar beds. Some cobbles and boulders seem to be present in greater proportions in the centre and towards the north of the area. The presence of potential reefs, according to the JNCC definition is shown in Figure 6. It shows that there is no evidence of the presence of reefs at most sampled sites in the proposed experimental area. Only 2 sites showed potential low reefiness (respectively 14% and 28% of cobbles/boulders/bedrock).

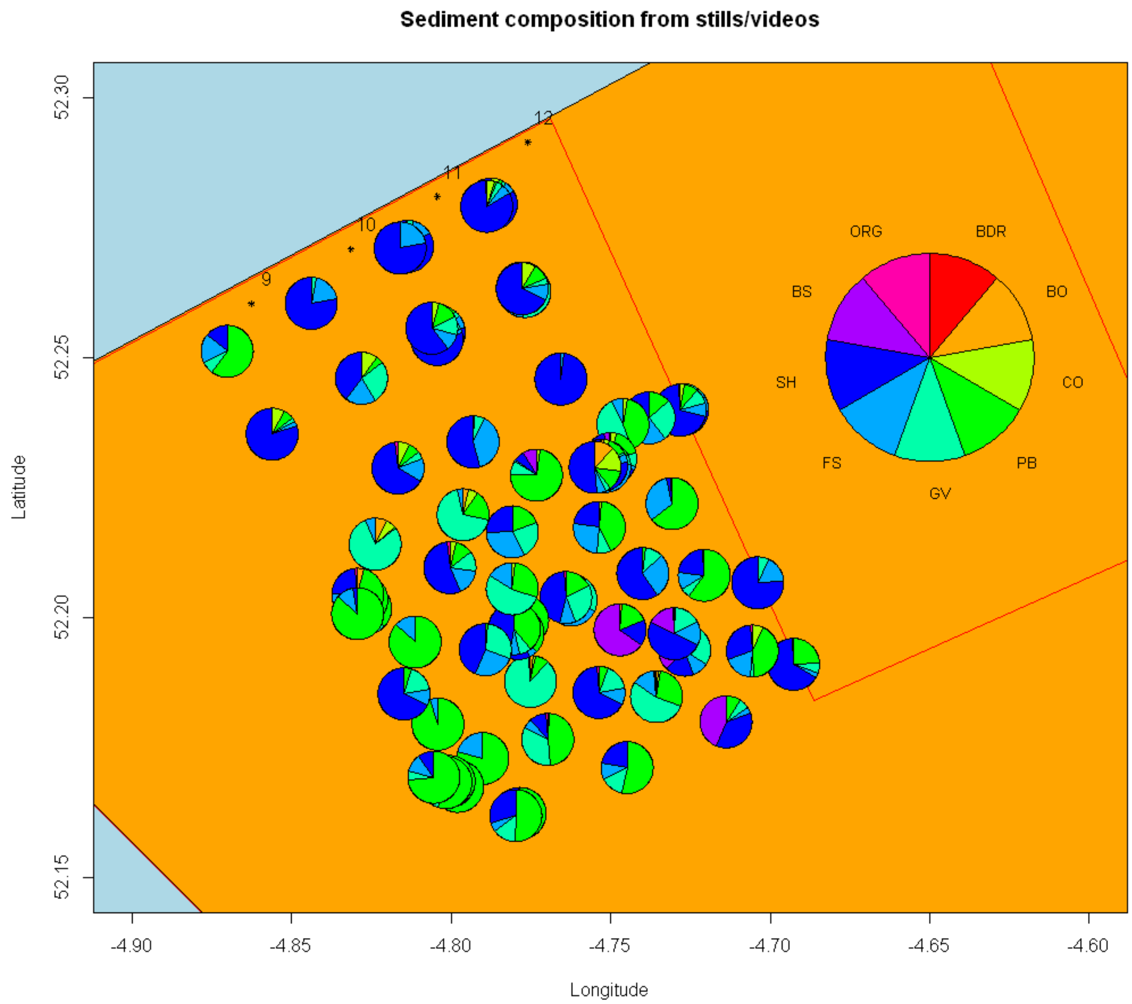


Figure 5. Sediment composition of all sites sampled between 2009 and 2012 in the proposed experimental area as mapped in Figure 1. Bedrock (BDR), Boulder (BO), Cobble (CO), Pebble (PB), Gravel (GV), Fine sediment (FS), Shells (SH), Brittle stars (BS), Other organism (ORG).

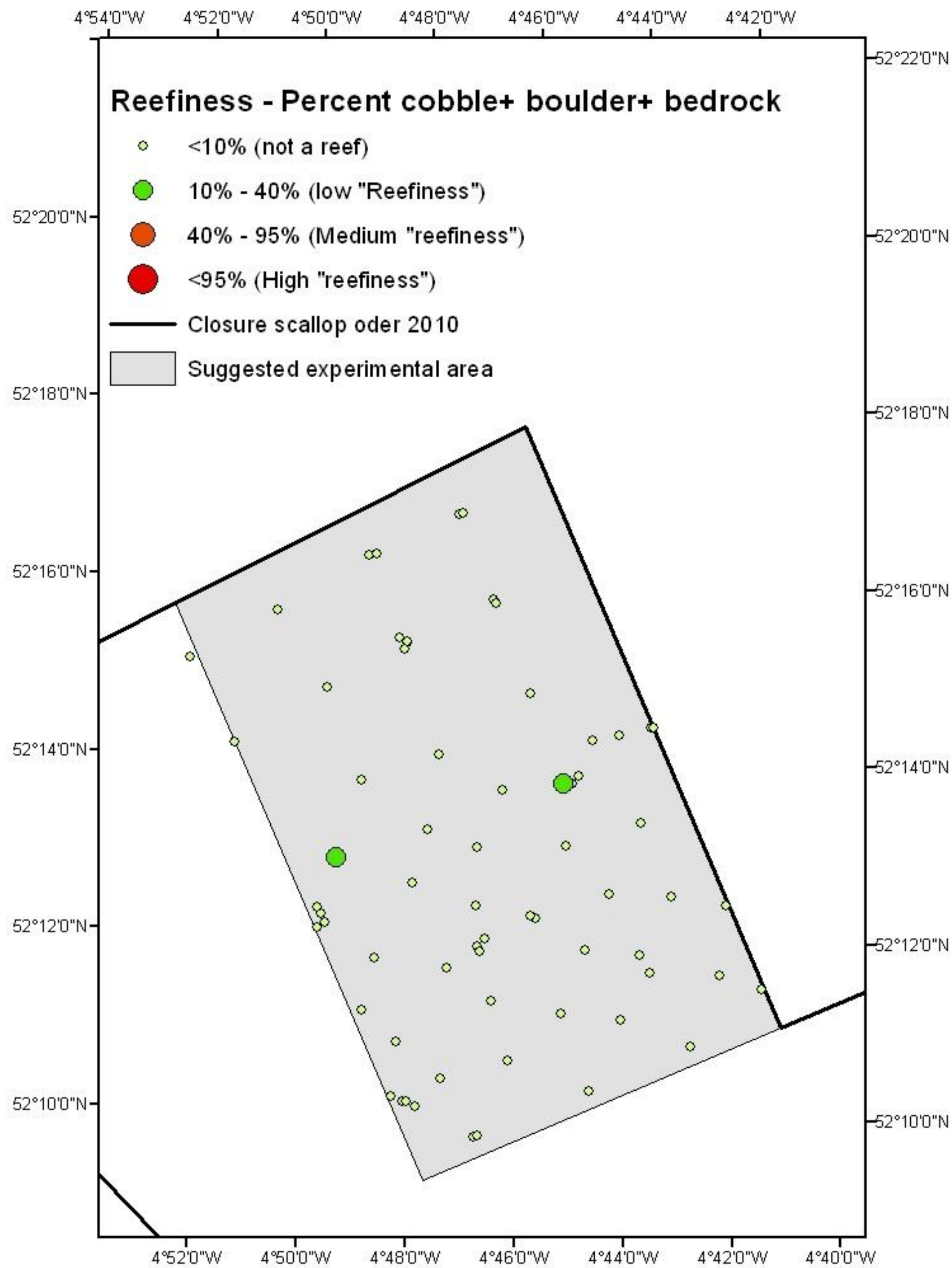


Figure 6. Percentage of cobble and boulder coverage (including bedrock) classified according to 'stony reef' criteria outlined by JNCC for all sites sampled between 2009 and 2012 in the proposed experimental area as mapped Figure 1.

4 - Side scan surveys

Based on the above data on sediment composition from video surveys and previous knowledge, NRW advised on which areas should be targeted for further investigation by side scan (Figure 7).

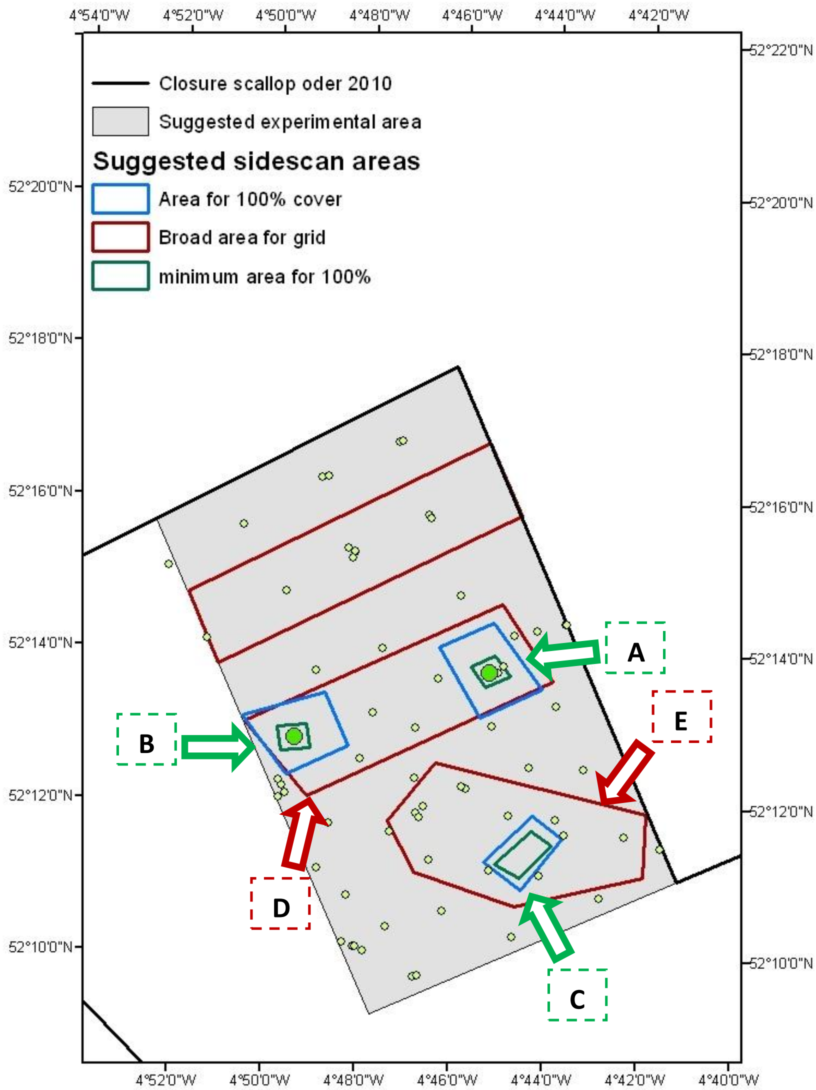


Figure 7. Areas where side scan surveys were advised by NRW, overlaid on cobble and boulder coverage (see Figure 6 legend). The red boxes were to be covered by a grid of side scan lines, the blue boxes were for 100% cover if possible with minimum 100% coverage of the green boxes in case the coverage of the blue areas was not logistically feasible.

Figure 8 shows the coverage that was achieved during the survey conducted by the Welsh Government in May 2013.

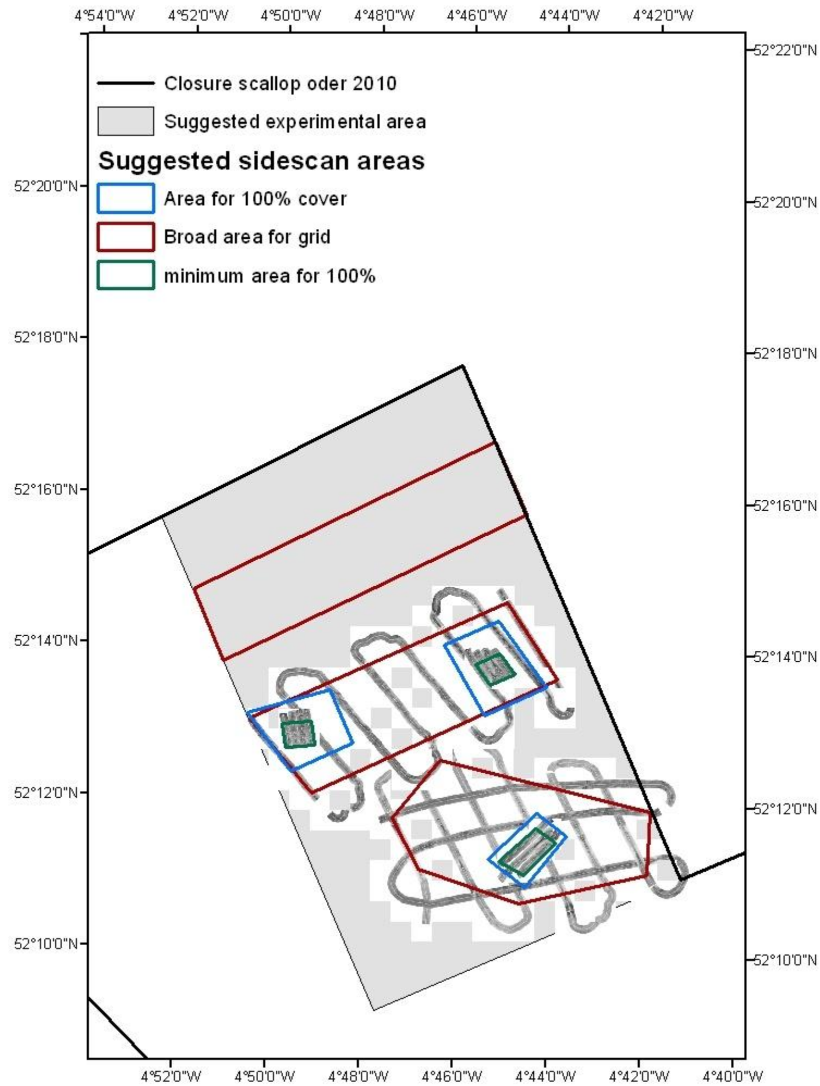


Figure 8. Side scan survey conducted by the Welsh Government in May 2013, with NRW recommended side scan overlaid (see Figure 7 legend).

As it was not logistically possible to cover every box identified by NRW during the short period of time available for the side scan survey, the northern red area was not surveyed and the blue boxes were not covered at 100%. However, the green boxes (the minimum requirement) were covered at 100% and two out of three red boxes were covered with a grid, following NRW advice. Additionally, 3 side scan lines, running from north to south of the suggested experimental area, had been completed by the School of Ocean Sciences, Bangor University, during a survey in June 2010. Those lines partly cover the northern red box in which NRW had advised to conduct a gridded side scan survey in May 2013. The lines also add information in the blue boxes and the 2 southern red boxes (Figure 9).

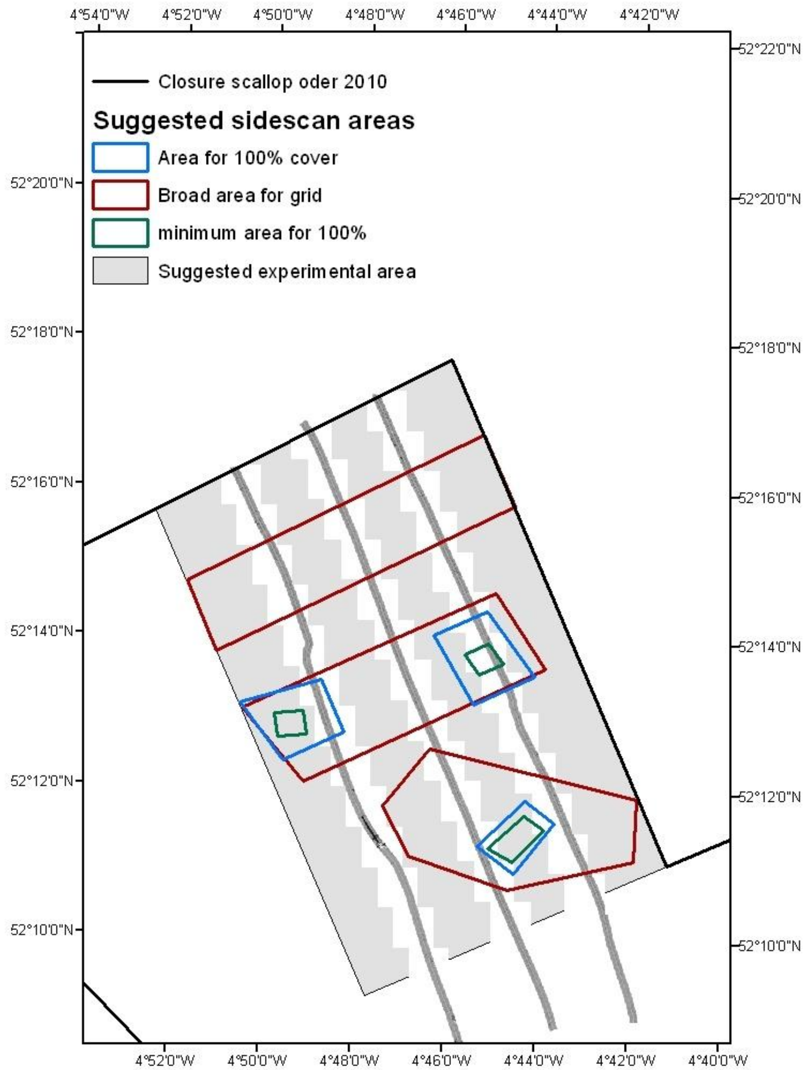


Figure 9. Side scan survey conducted by the School of Ocean Sciences, Bangor University, in June 2010, with NRW recommended side scan overlaid (see legend figure 7).

The first side scan survey (Figure 8) was conducted over a 2 day period from 1st to 2nd May 2013 using the Welsh Government Fisheries Patrol and Science vessel MV Cranogwen. The side scan sonar system was an EdgeTech 4125 series dual frequency side scan sonar system using a 200m tow cable on a winch powered by the boats generator. A sonar range of 100m (total swath width 200m) was employed throughout, with the tow-fish altitude above the seabed kept between 5 to 10m.

The second side scan survey (Figure 9) was conducted over a 3 day period from 22nd to 24th June 2010 using the fishing vessel MFV Mercurius. The side scan sonar system was a Cmax CM2 system using a 300m tow cable on a 24v battery powered winch. A sonar range of 100m (total swath width 200m and sonar frequency 325kHz) was employed throughout, with the tow-fish altitude above the seabed kept between 5 to 10m. All survey lines were run perpendicular to the coast as these were found to give the clearest images with the more distinct shadows in the December 2009 survey (Hinz et al 2010b).

Analysis of side scans

Side scans were visually analysed and maps were created in an effort to highlight the visible differences in texture. It has to be noted however that the interpretation was made difficult by the occurrence of horizontal lines in the images, likely due to the speed at which the vessel steamed during the survey. Furthermore, two of the areas which were covered at 100%, areas A and B (Figures 7 and 8) were covered perpendicularly and horizontally to the coast. As already noted during the December 2009 survey (Hinz et al. 2010a), the lines that were perpendicular to the coast gave the most distinct shadows, i.e. were better to identify features. Only perpendicular lines were therefore analysed. The lines in area C were not perpendicular to the coast, therefore the best direction, i.e. the direction that showed most distinguishable shadows, was analysed.

Overall, the side scans confirmed the patchiness of the seabed at fine scale, showing a mosaic of sand ripples, rougher patches and featureless areas. Except for sand ripples, it was difficult to visually define patches of different substratum types. There were some isolated boulders which could be identified by their shadows but those were scarce and therefore not mapped out as layers. Three layers were created: sand ripples, rough (where some texture, potentially gravelly substratum types with potential presence of pebbles, cobbles and boulders) and featureless (either by the absence of feature or the angle of the side scan not reflecting the feature). See example Figure 10. Picture and video tows from all surveys conducted between 2009 and 2012 were used to ground truth the side scan images (see below).

Rough   Sand ripples   Featureless

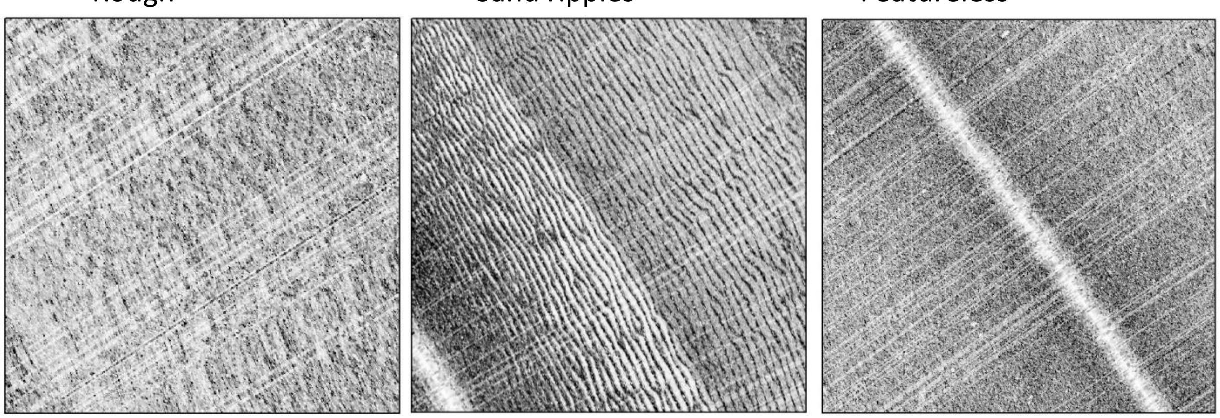
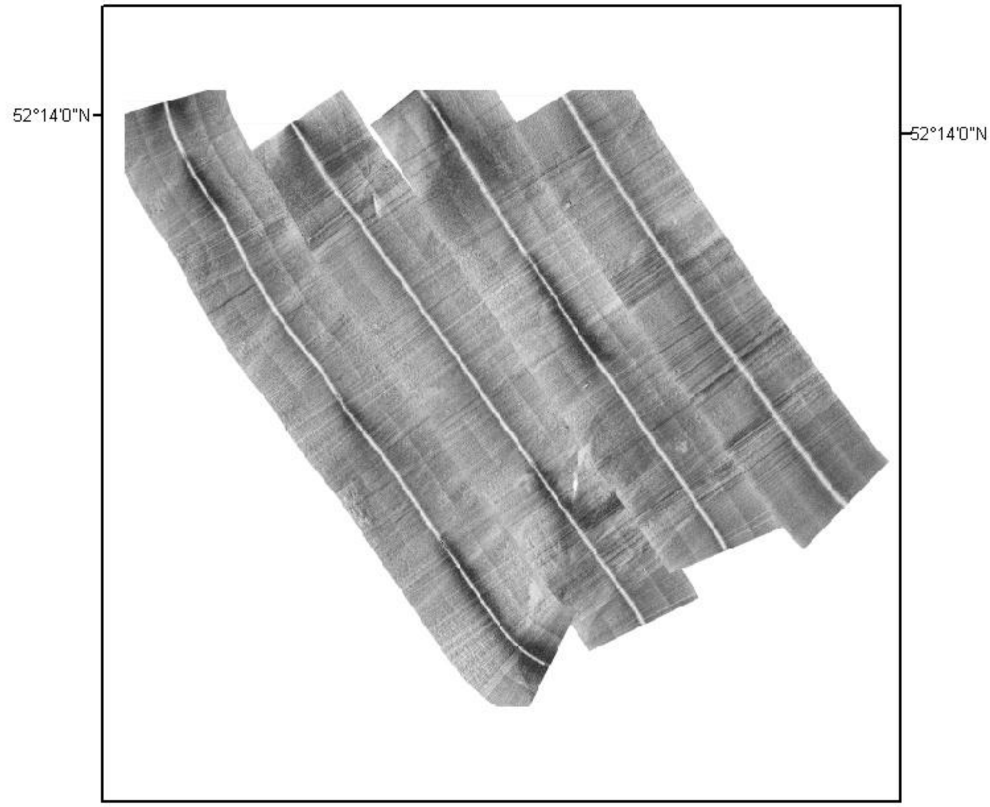
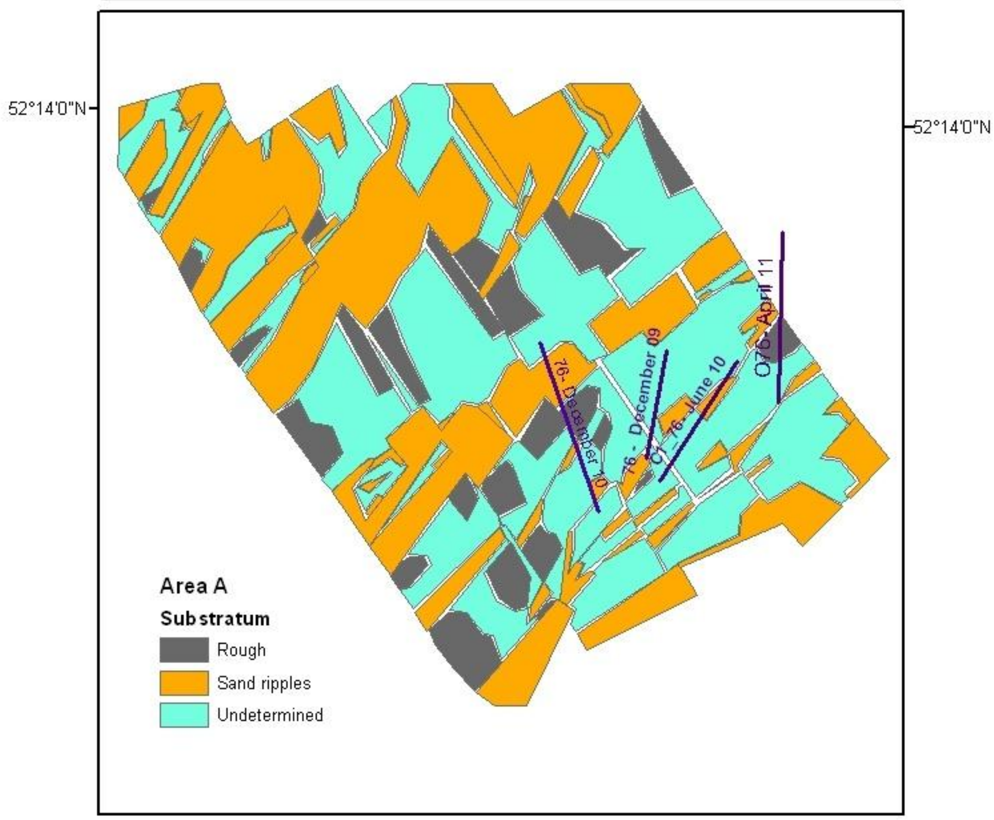


Figure 10. Example of sand ripples, rough and undetermined (featureless) areas on the side scan images

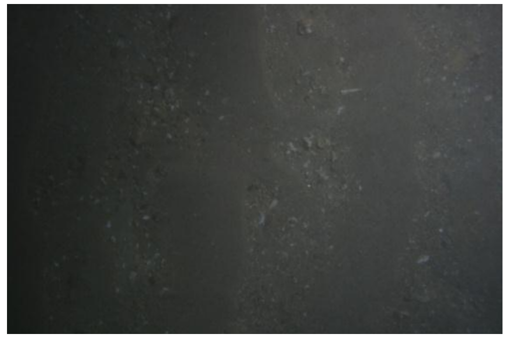
<u>Area A (see figure 5 for location)</u>

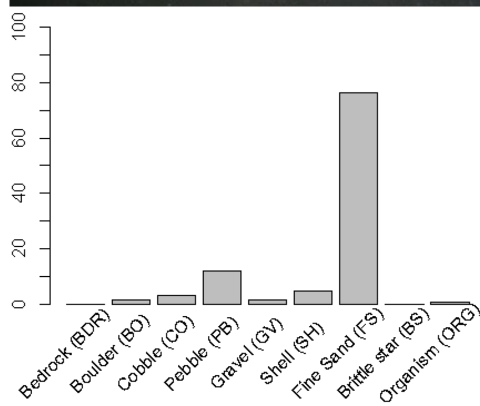




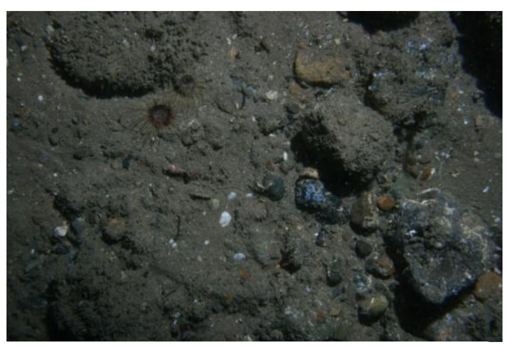
Ground-truthing of Area A (Figures show percentage cover by each substratum type)

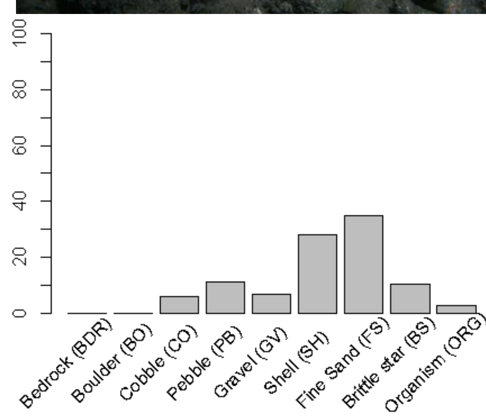
Station 76 December 2009



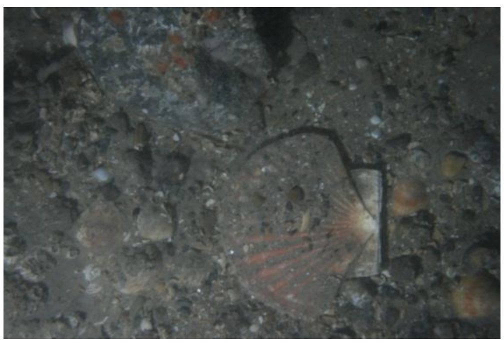


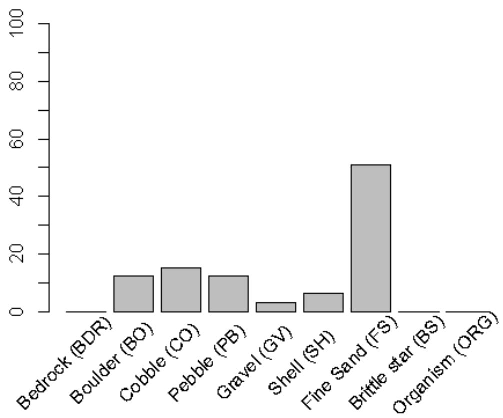
Station C1_76 June 2010



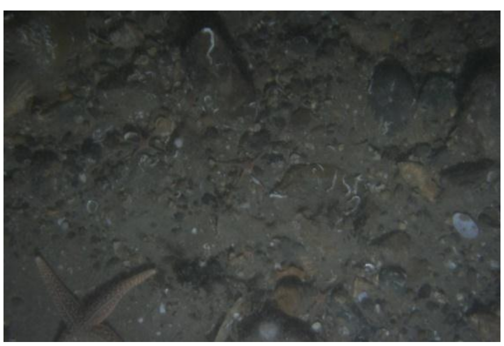


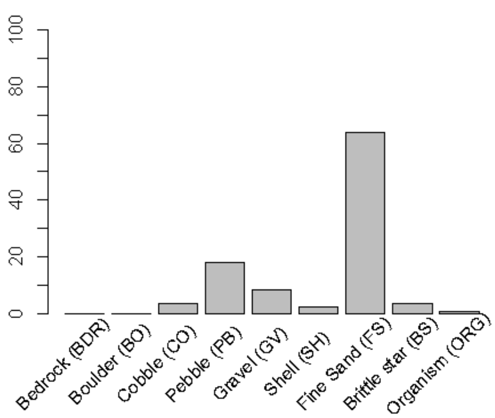
Station 76 December 2010



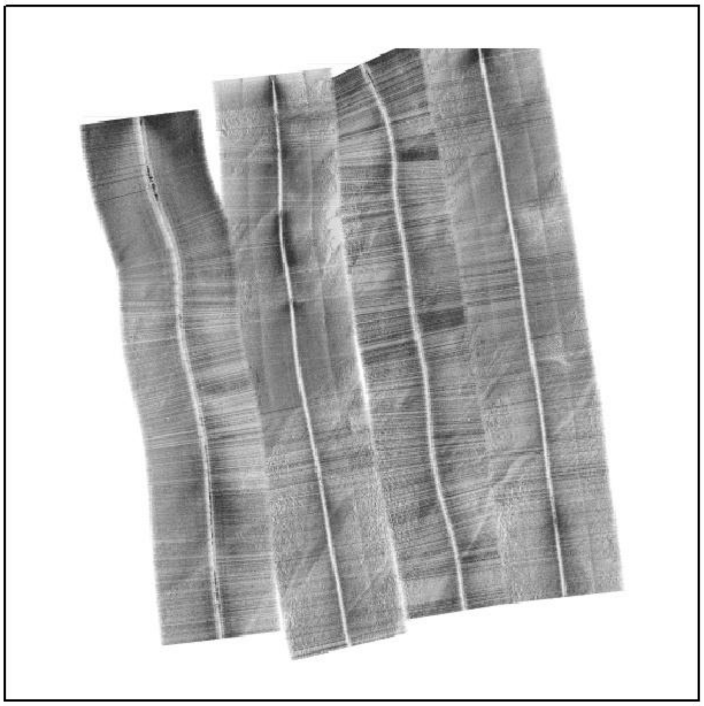


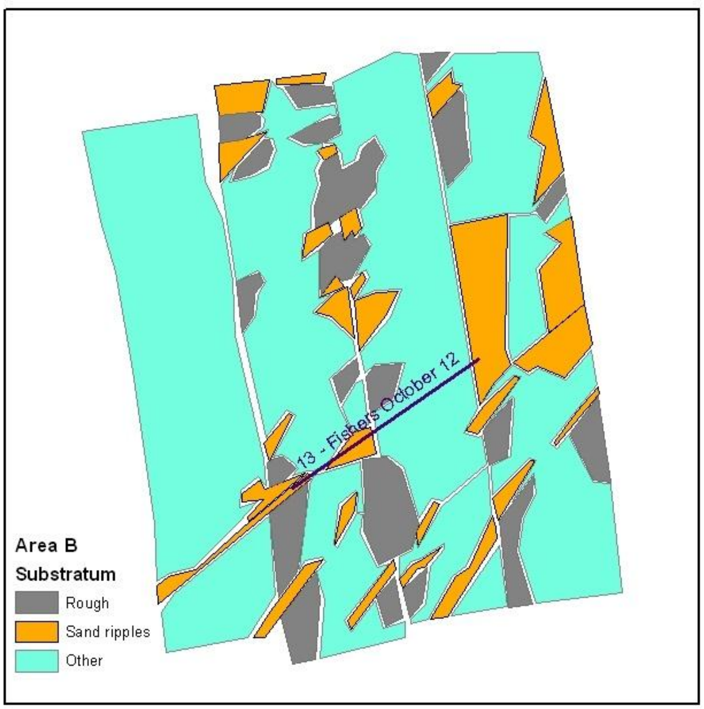
Station O76 April 2011





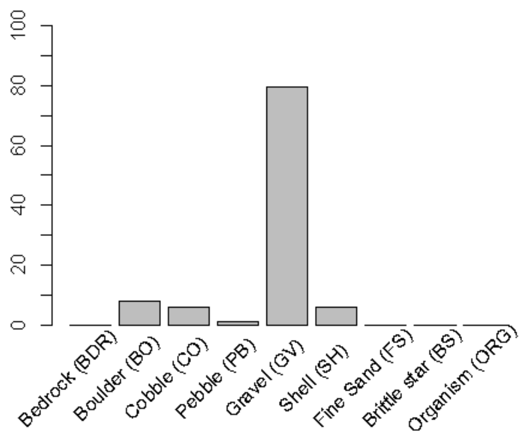
Area B (see figure 5 for location)



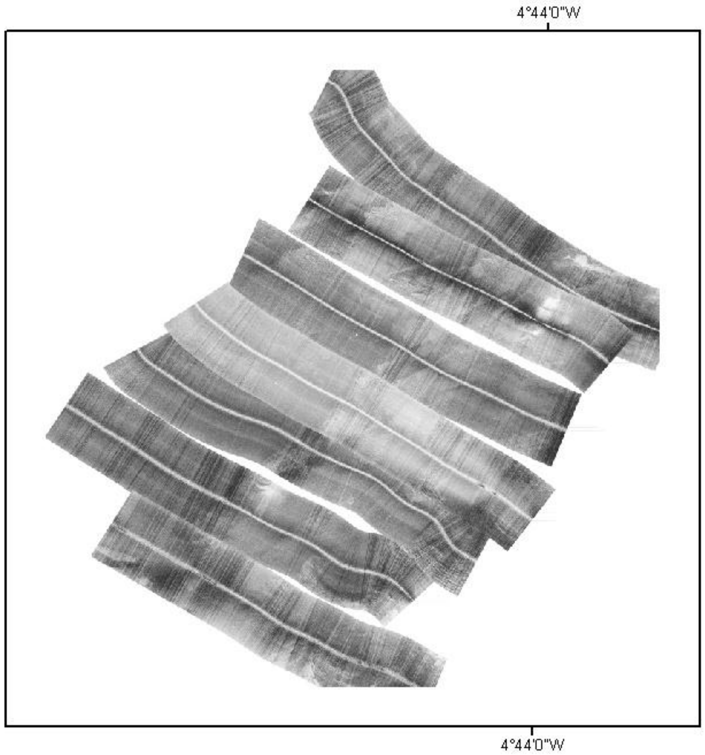


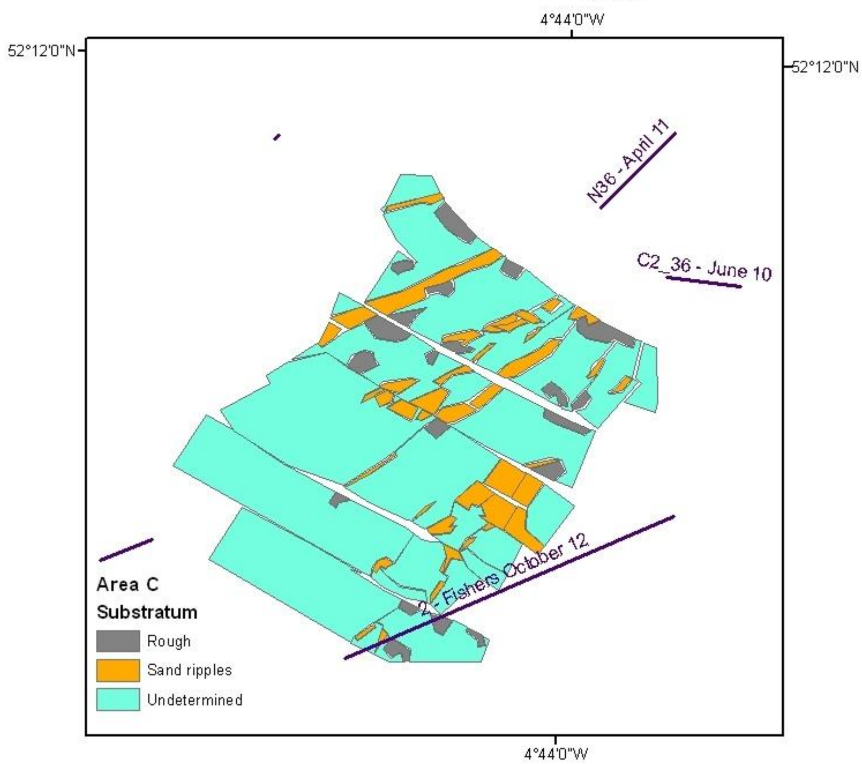
Ground-truthing of Area B

Station 13 Fishers October 2012



Area C (see figure 5 for location)

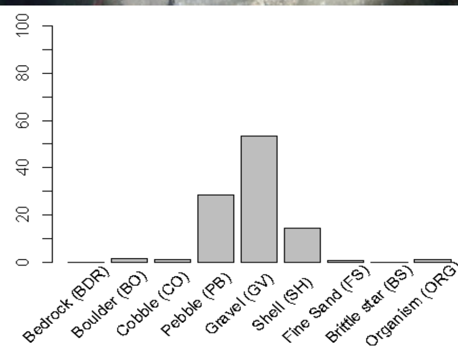




Area C – Ground-truthing

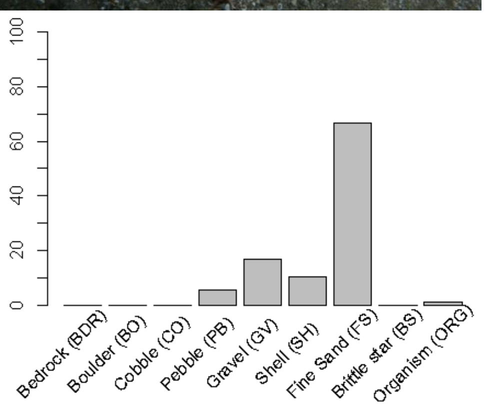
Station 2 Fishers October 2012



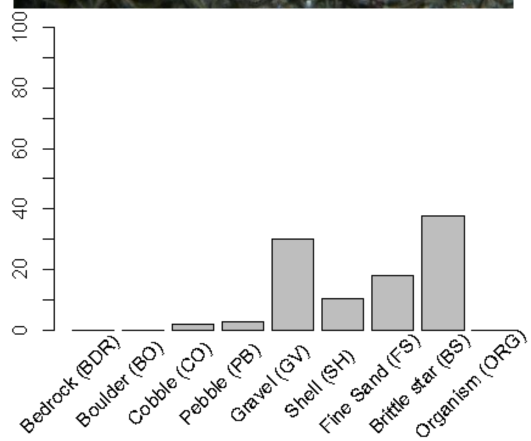



Station C2_35 June 10

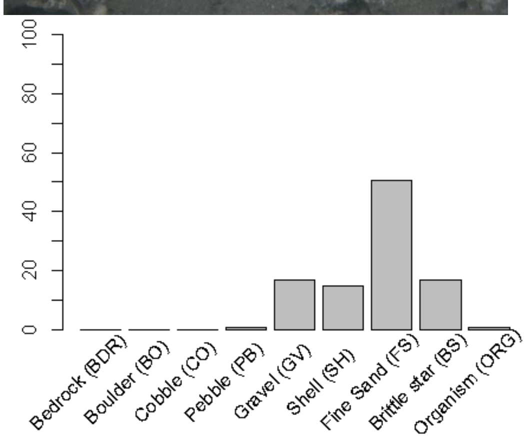


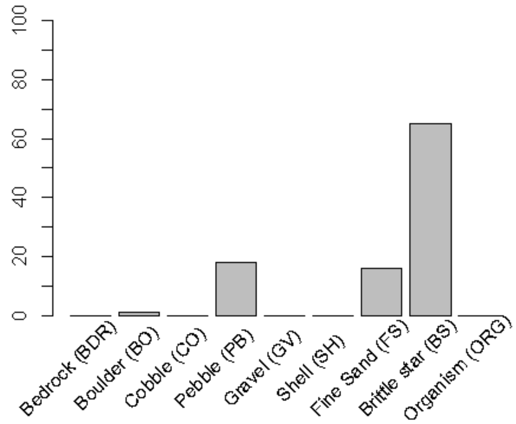
Station C2_36 June 2010



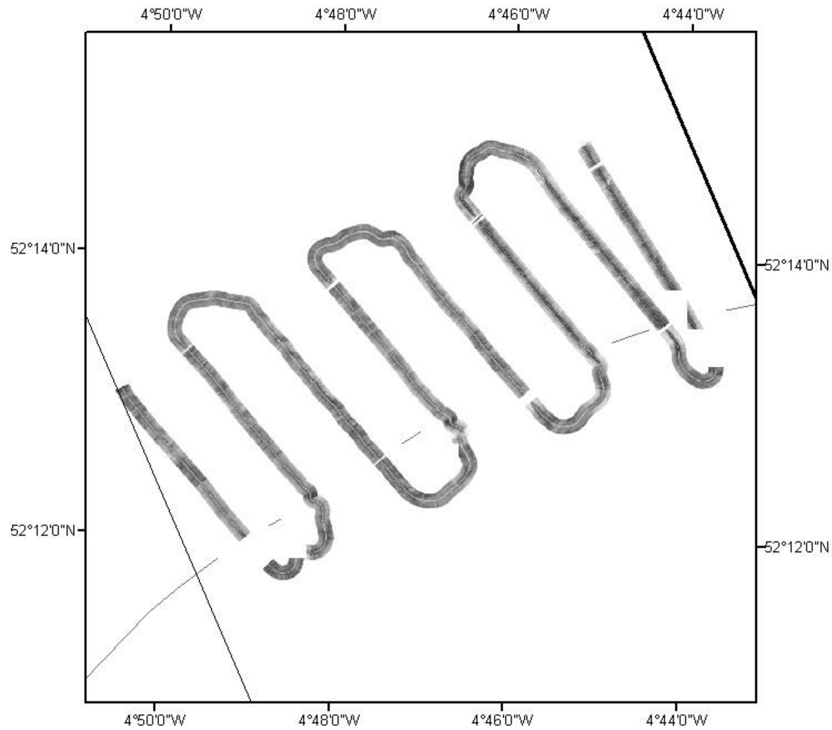
Station N36 April 2011

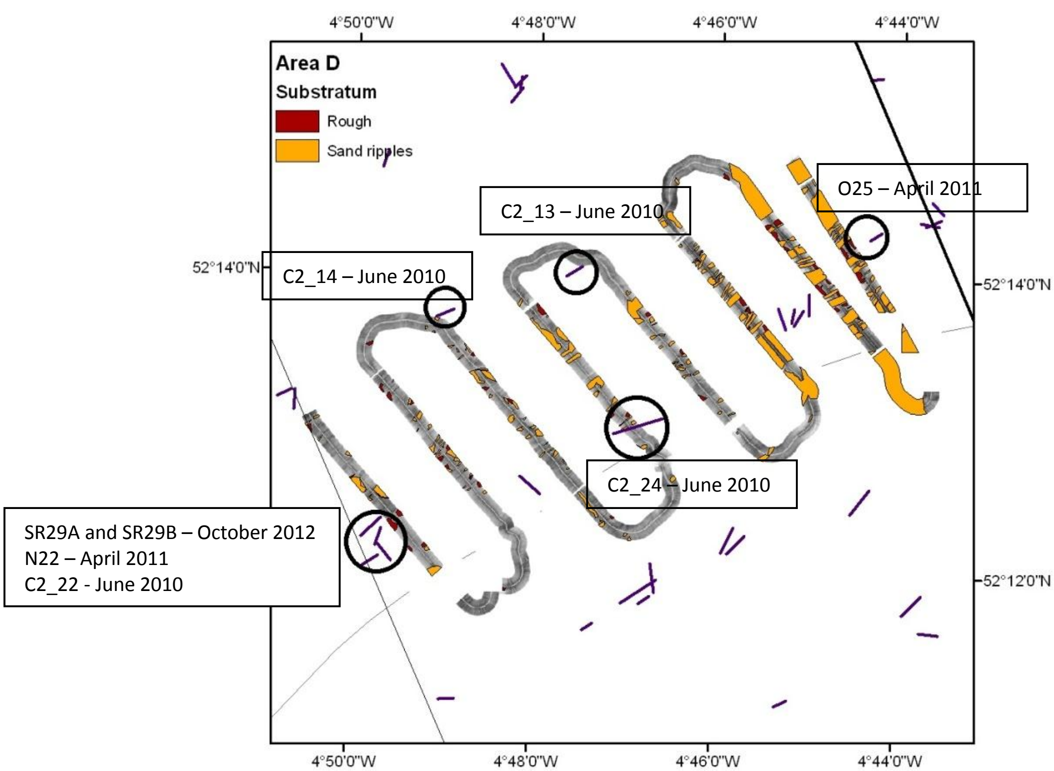


Station 7 Fishers October 2012



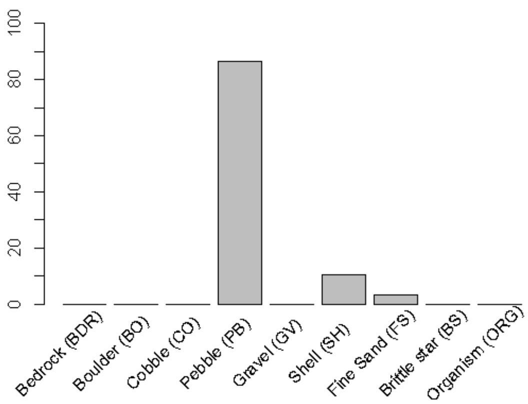
<u>Area D (see figure 5 for location)</u>



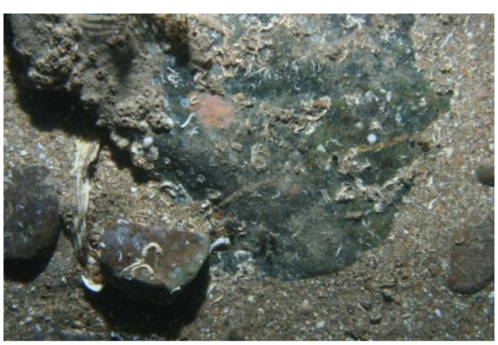


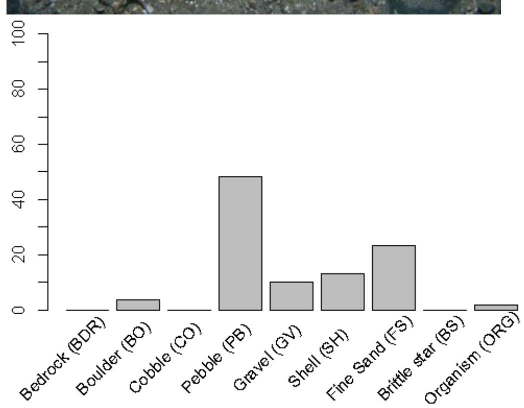
Ground-truthing Area D

Station SR29 A October 2012

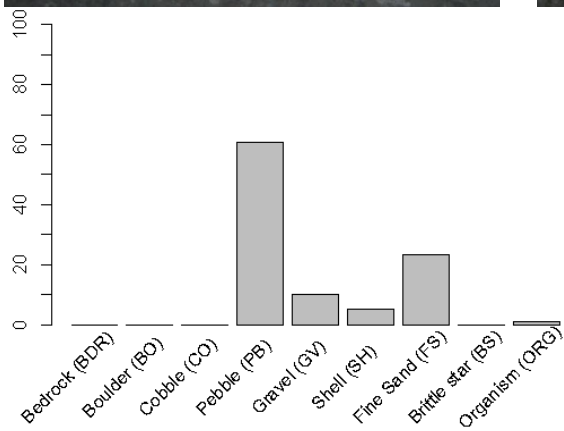


Station SR29 B October 2012





Station N22 April 2011



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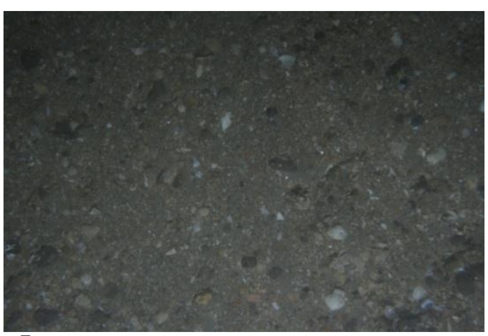
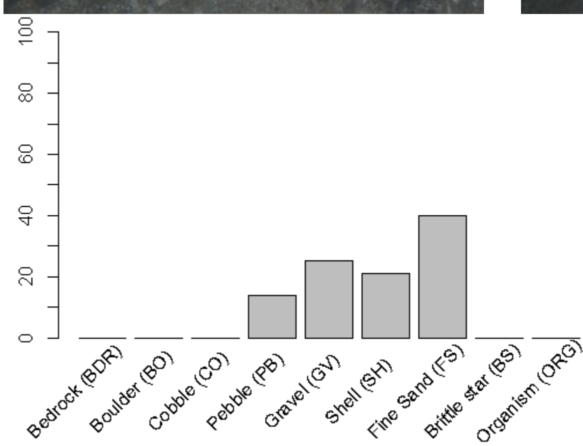
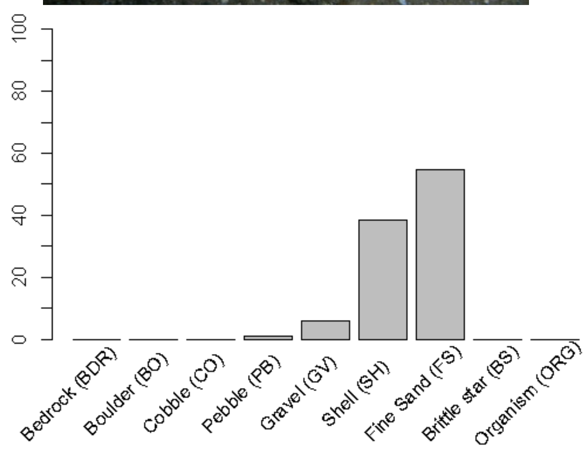




Station C2_13 June 2010



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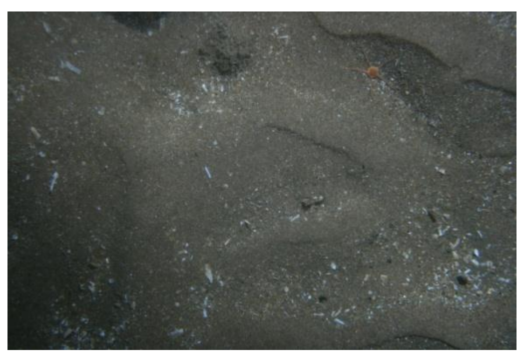

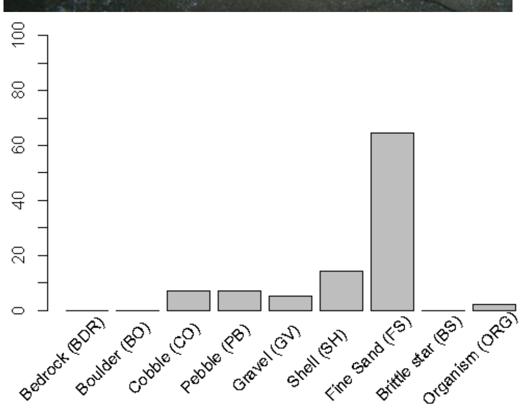

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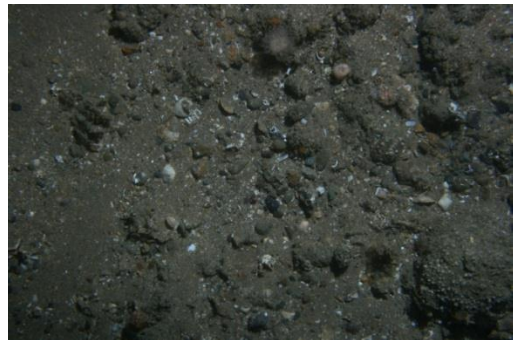

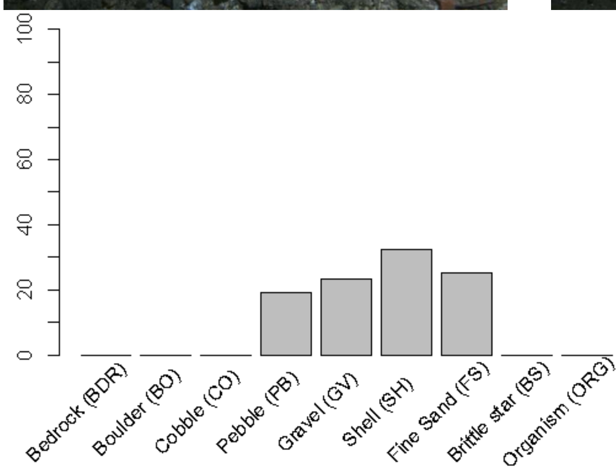

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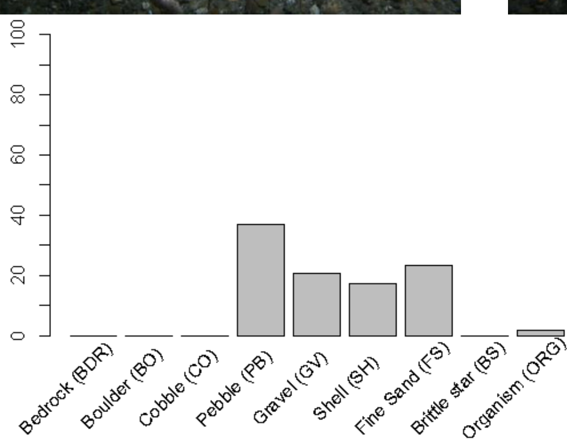
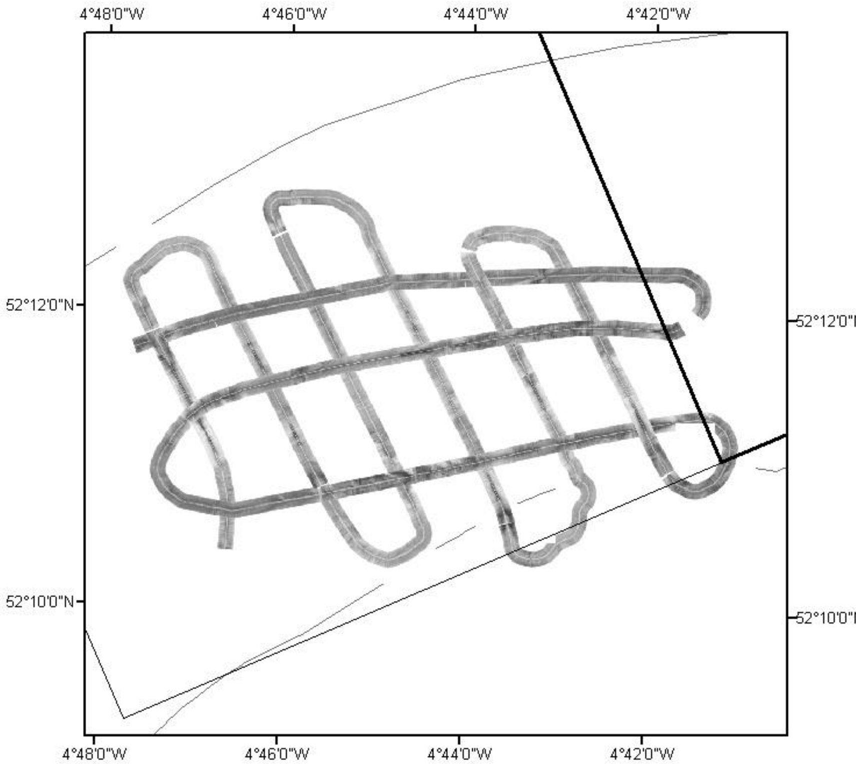
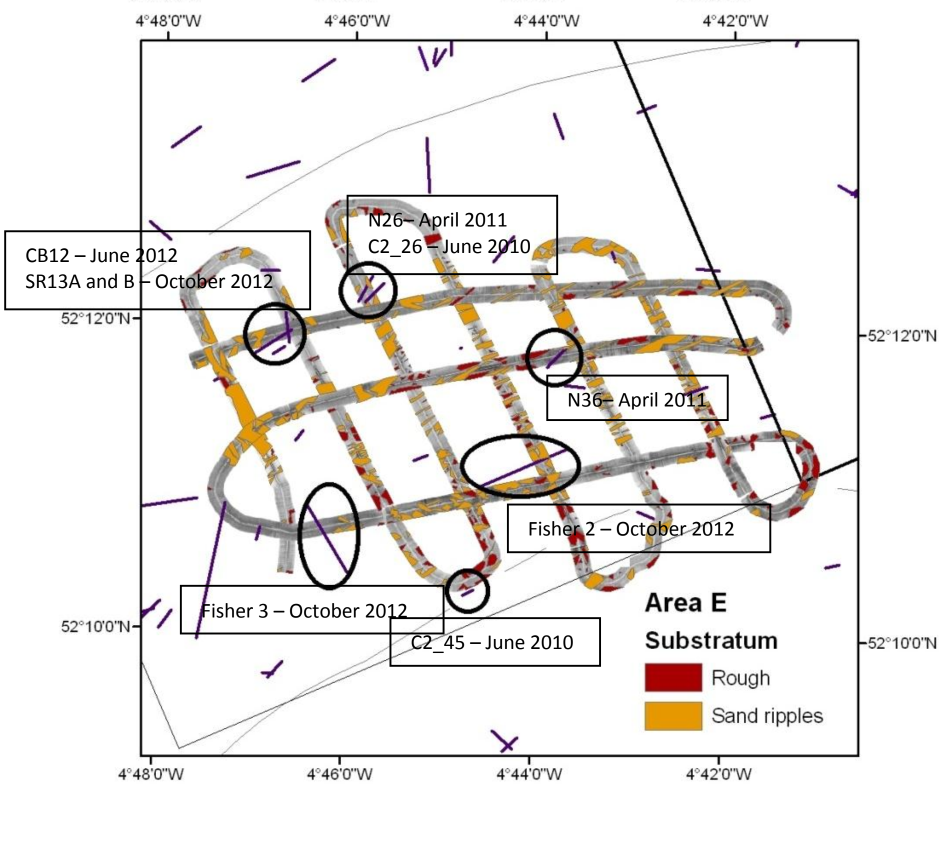


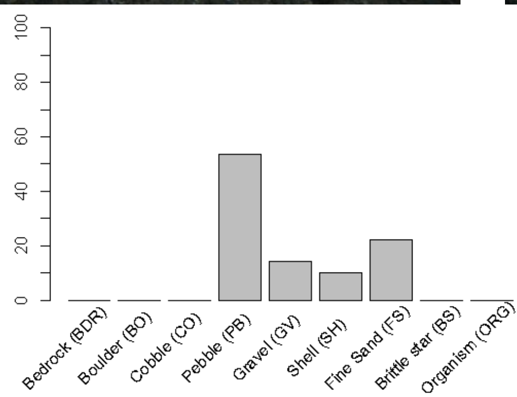
Area E (see figure 5 for location)



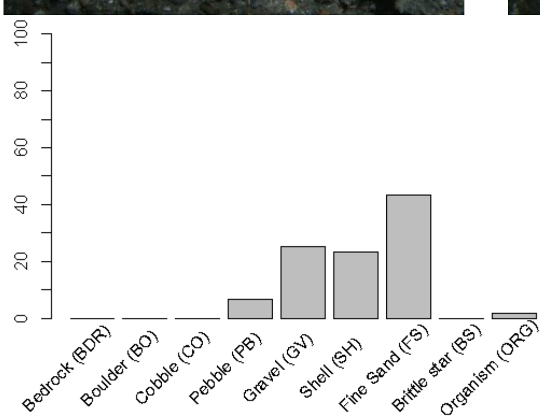


Ground-truthing Area E

Station C2_45 June 2010



Station C2_26 June 2010



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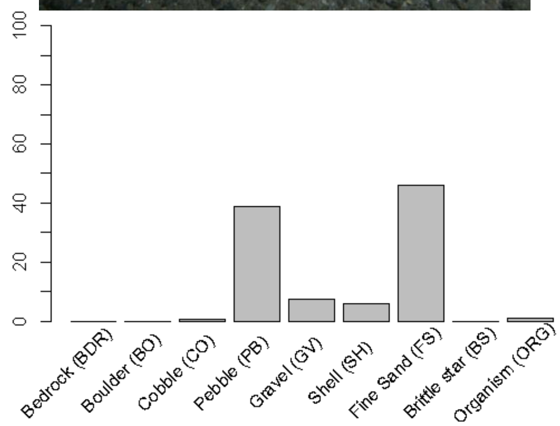
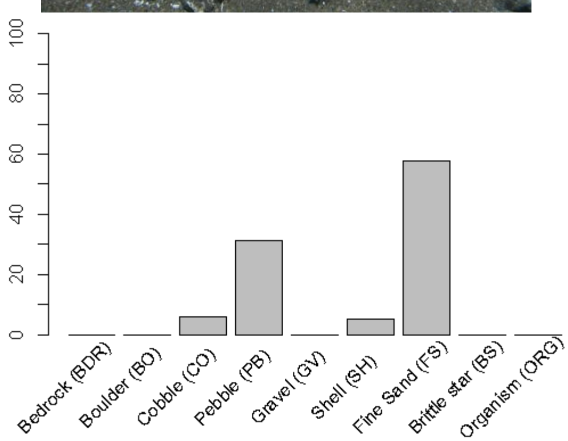


Station SR13A October 2012



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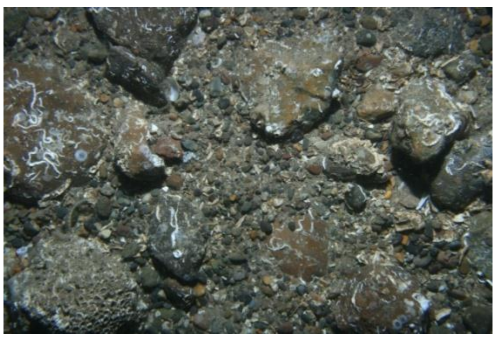
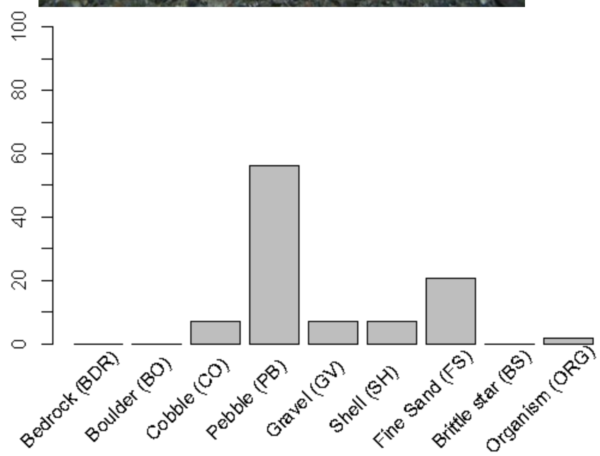
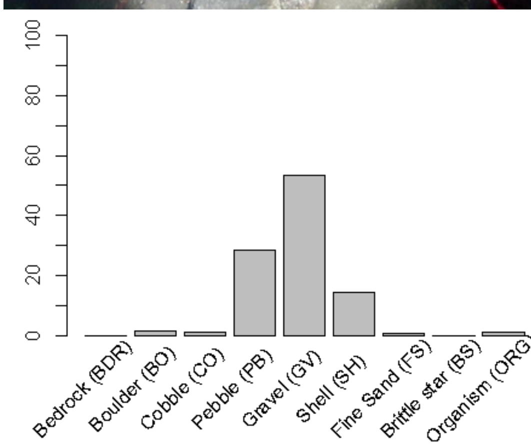
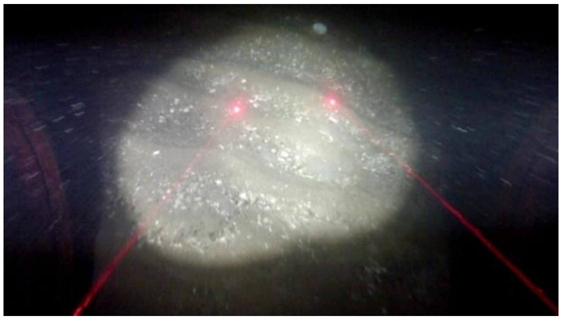


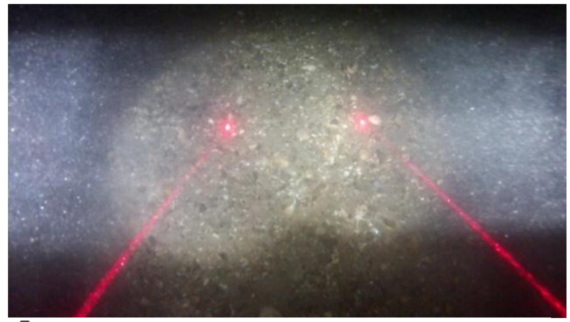


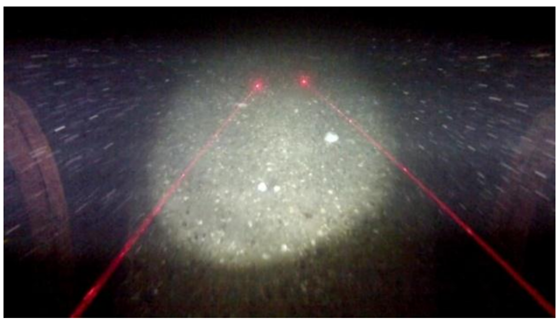
Station 2 Fisher October 2012

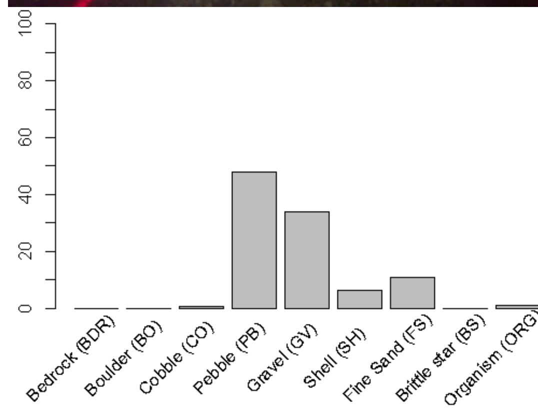


Station 3 Fisher October 2012









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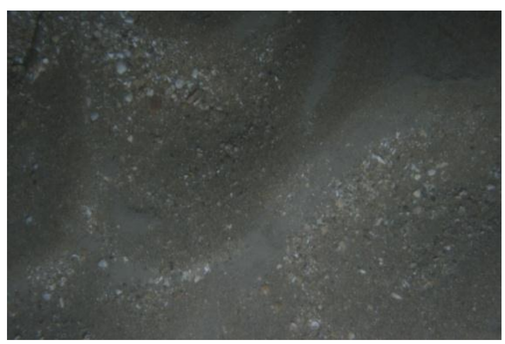

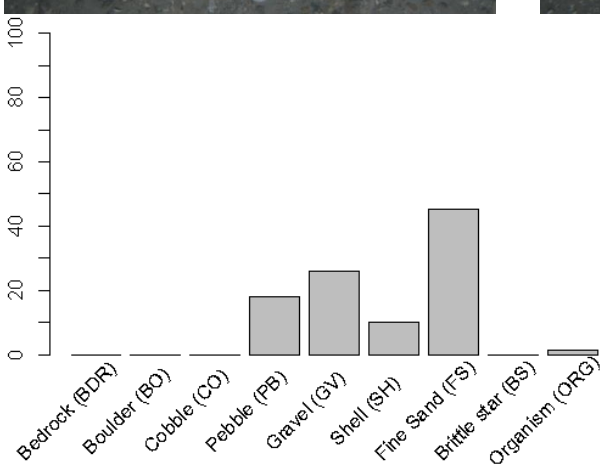

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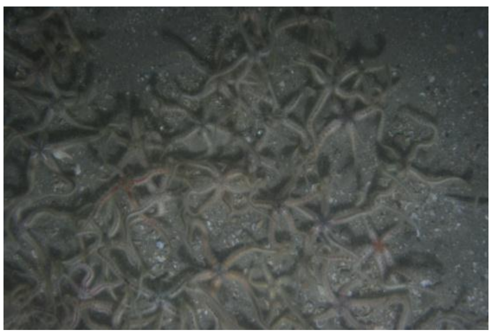
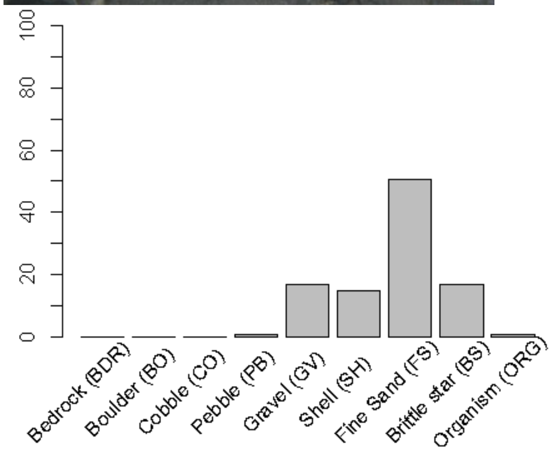
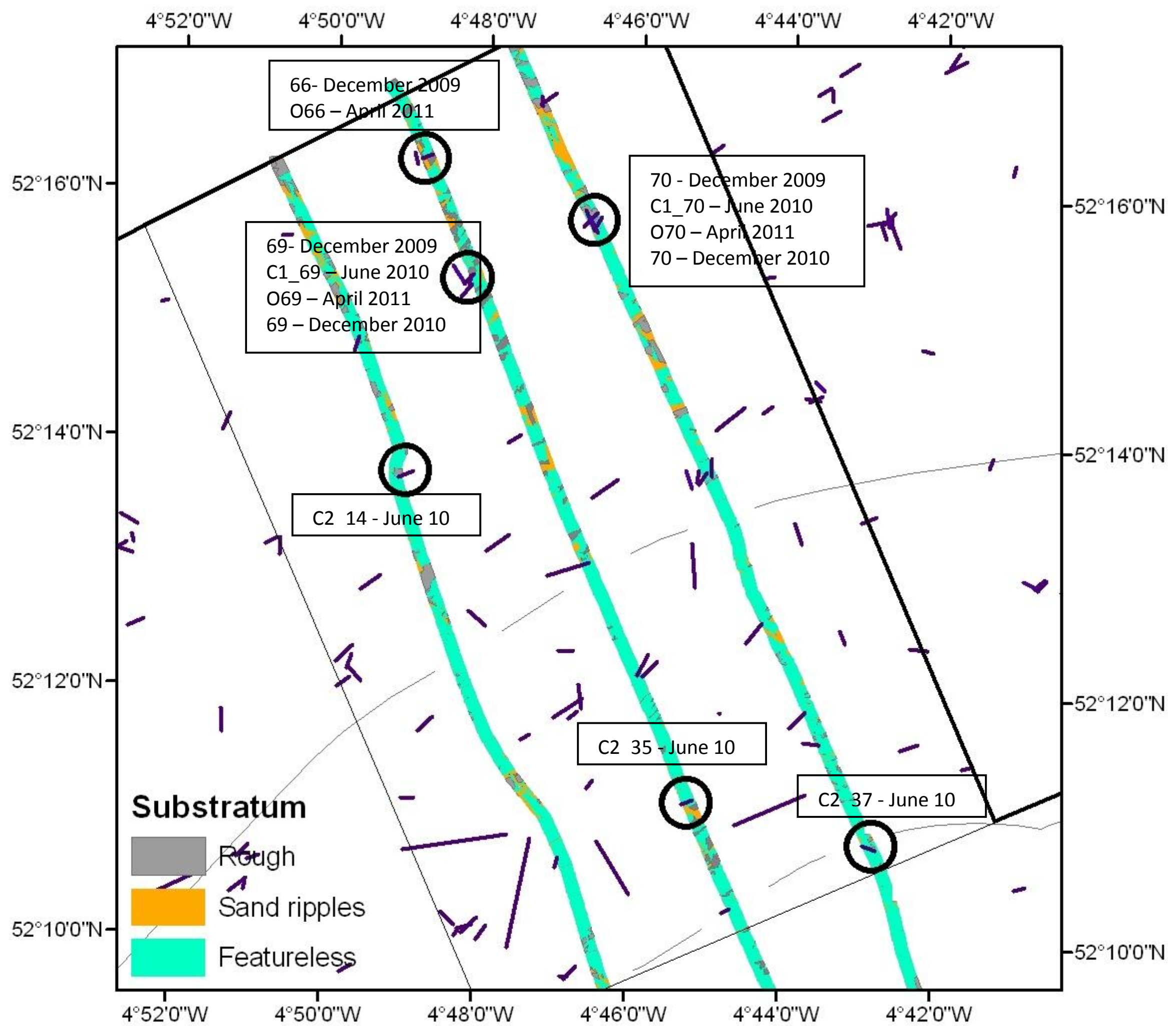


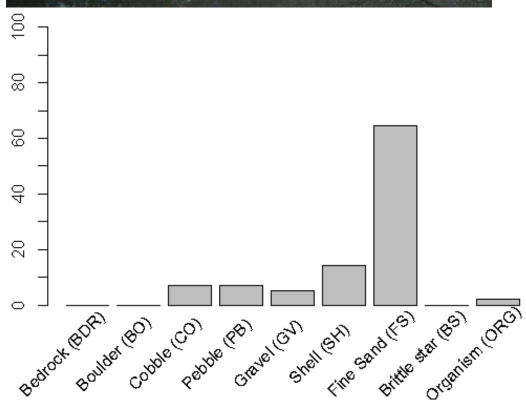


Side scan lines June 2010



Ground-truthing side scan lines June 2010

Station C2_14 June 2010



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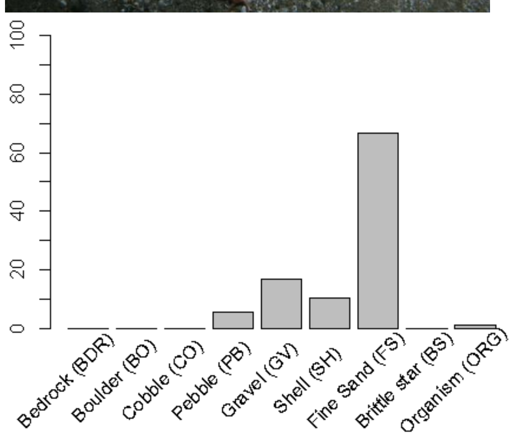

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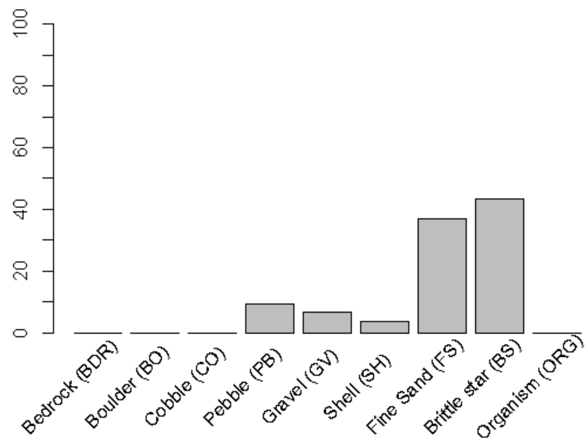
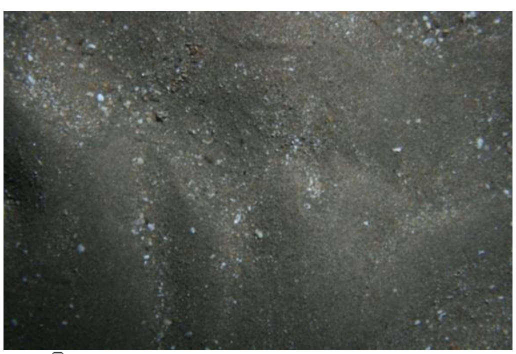
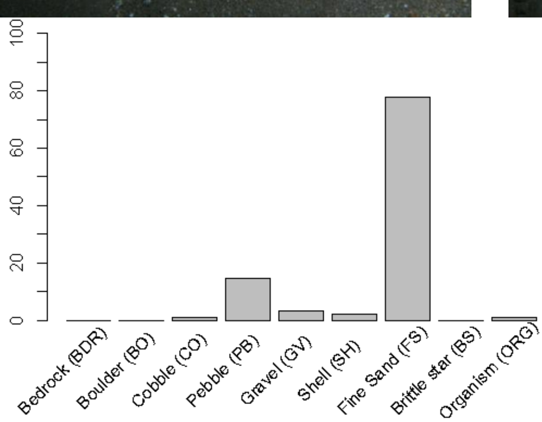


Station C1_69 June 2010





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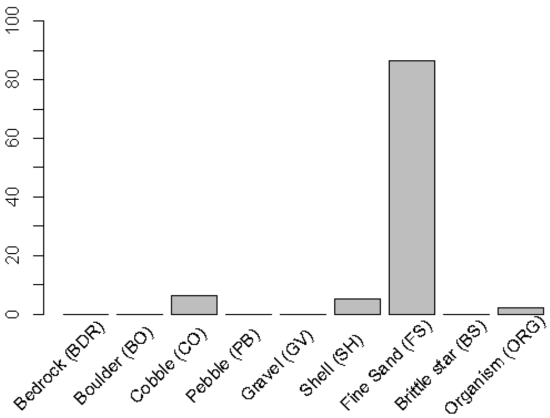
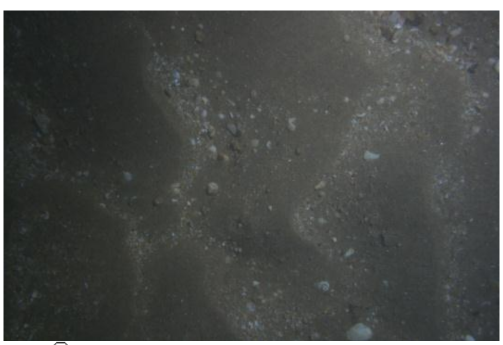
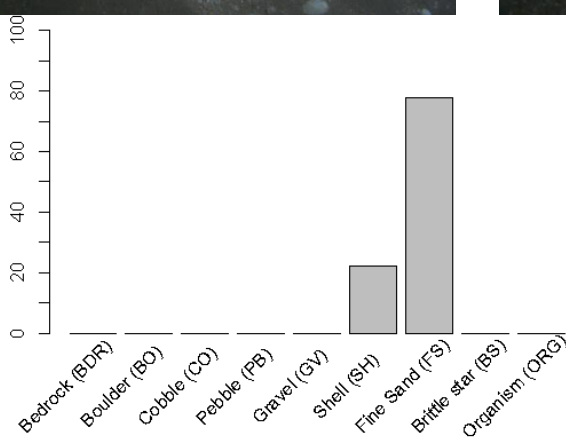


Station CB66 December 2009





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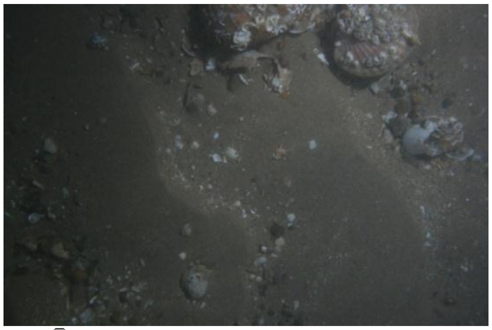

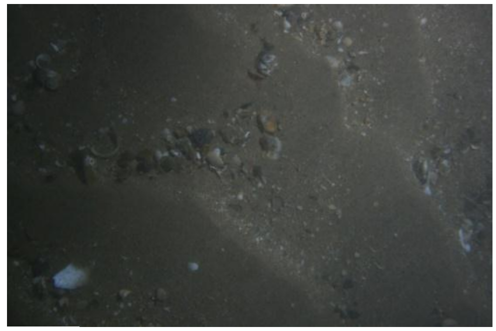

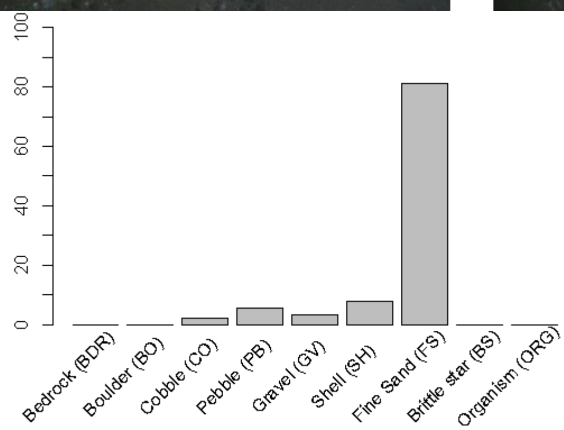

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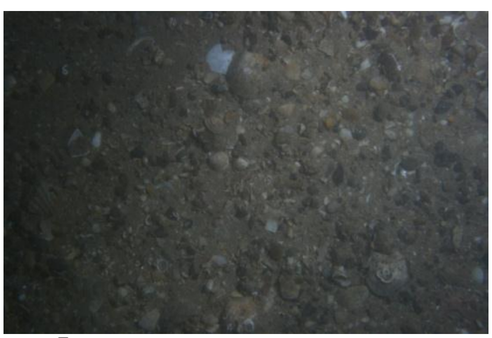

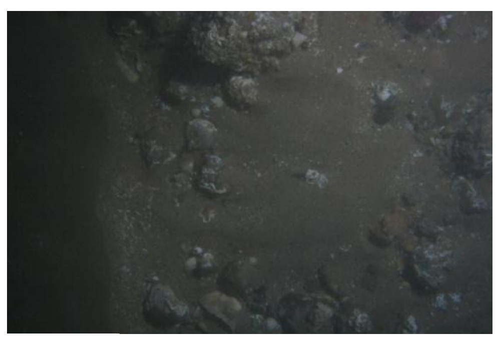

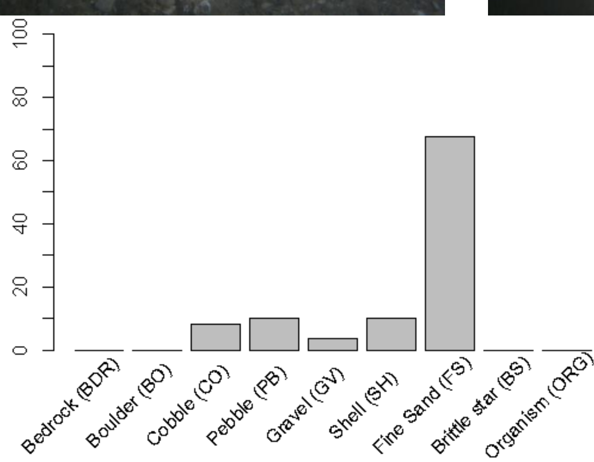

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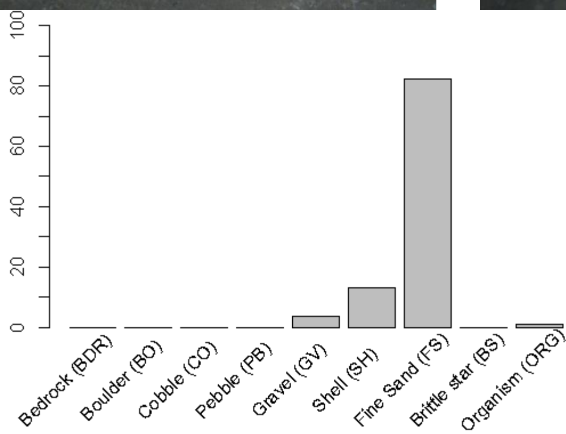

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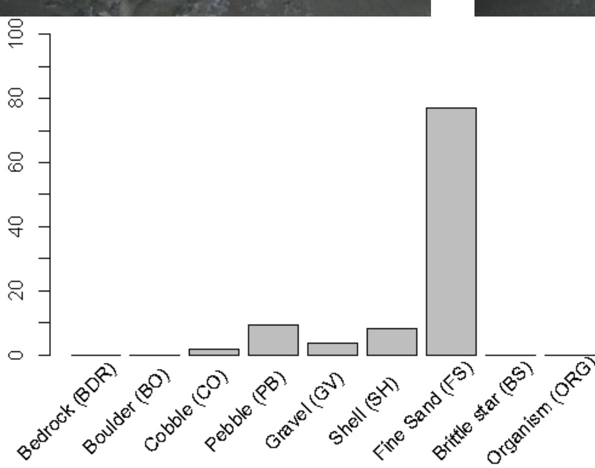

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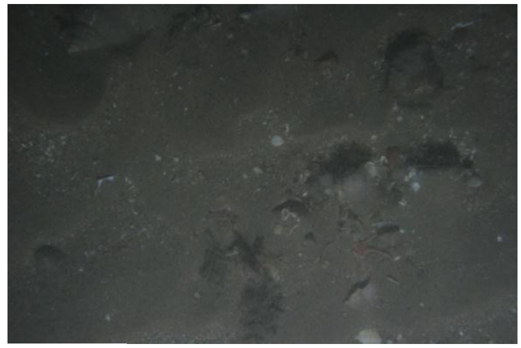

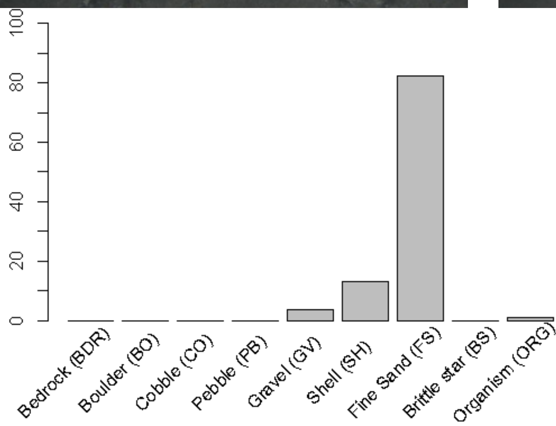

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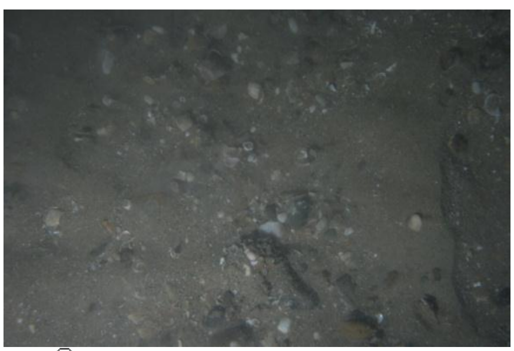

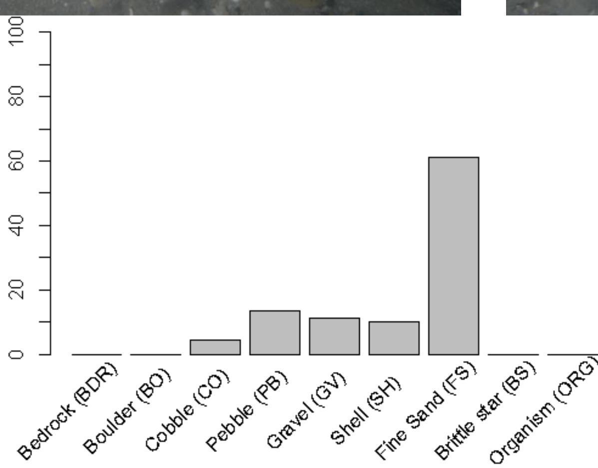

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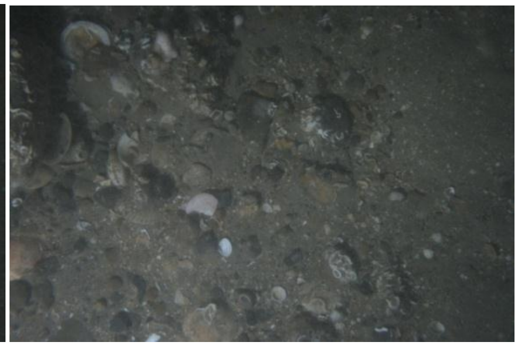


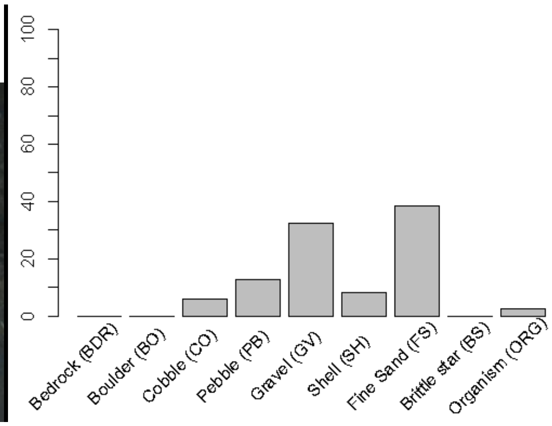

Interpretation of side scans

The easiest feature to recognise was the sand ripples. Isolated rocks and potentially rougher grounds could be spotted but generally the rest could not be identified without ground-truthing. It is usually difficult to determine gravelly, pebbly grounds from cobbly grounds based on a side scan image. However, wherever possible video tows were matched to side scan tows to try to identify substratum types. The length of the tows varied from about 200m to more than 1km. Even though the videos were taken at different times, the method showed whether resilient, stable cobble reefs existed at the sampled sites in the area proposed for the experiment. The video tows appeared to cross all different features on the side scans (sand ripples, rough and featureless areas). However, none of them showed a stable, structured cobble reef. The rough areas seem to correspond to patchy mixed grounds composed of varying percentages of gravel, pebbles, cobbles and larger rocks. This suggests that a few discrete areas could qualify as areas of low reefiness where less than 40% of cobbles are present at a scale of less than 1km^2, but in most of the proposed experimental area the available evidence suggest the absence of reefs (flat, featureless, <10% cobbles). There was no evidence at any of the ground-truthing sites of the side scans of areas of medium to high reefiness, nor did the side scan images themselves suggest the presence of elevated, dense, rocky reefs (as described in Table 1).

5 - Additional information

Two reports (Hinz et al. 2010a and b) and a published scientific paper, Sciberras et al. (2013), suggest that there are no major differences in terms of habitat or epifauna between the closed area and the proposed experimental area, probably due to the combination of sediment type and hydrodynamics, i.e. high level natural disturbance, of the area. The proposed experimental area appears to have a relatively low coverage of epifaunal species, suggesting again no reef or low reefiness (Figures 11 and 12). Due to the proportion of soft sediment compared to hard substratum, it is likely that the biota is mostly composed of infaunal organisms. As an indication, some grab samples were taken at 5 random locations across the western closed area of the SAC in October 2012 and the number of species varied between 6 and 44 with an average of 24 species per grab (3 grabs per station were analysed). Densities would be more informative but the data analysis is not yet completed and will contribute to another report or scientific paper in the near future.

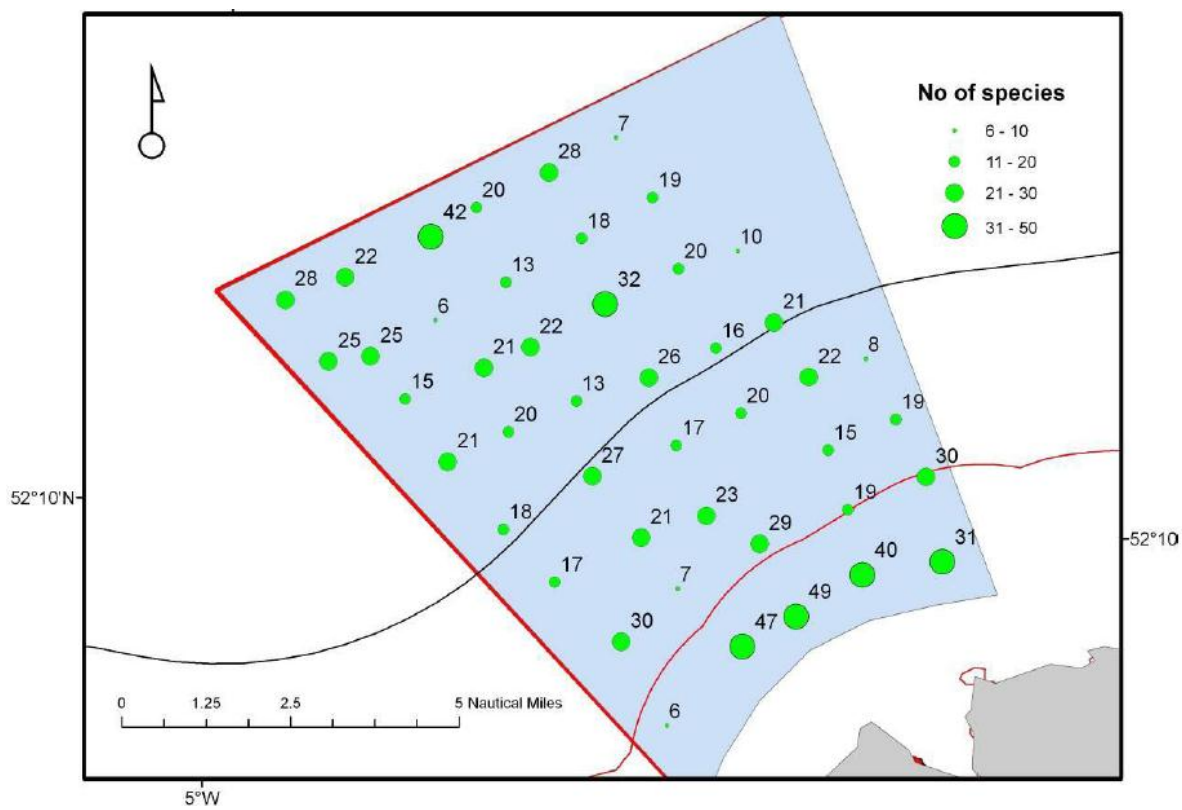

Figure 11. Number of species per camera tow in the area west of the open box in June 2010 (from Hinz et al. 2010b)

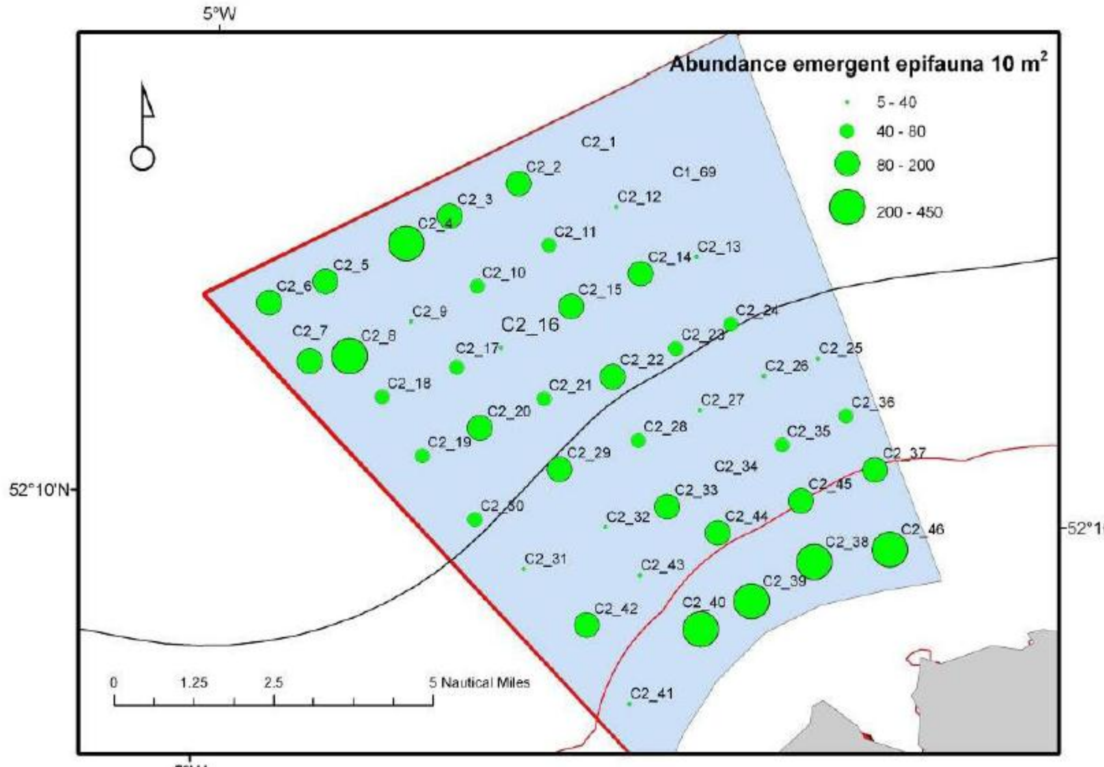

Figure 12. Abundance (number of individuals per 10m^2) of emergent epifauna (including colonial organisms) at each station in the area west of the open box in June 2010 (from Hinz et al. 2010b).

Abundances of emergent epifauna, generally associated with hard substrates, were found to be highest at stations located near the coast, reflecting the distribution of the cobble and boulder habitats suggested in the NRW map of reef and sandbank features (Figure 2). The proposed experimental area (approximately limited on the west by the axis going from station C2_2 to C2_44 in Figures 11 and 12) showed the lowest abundances of epifaunal species.

6 - Experimental design

The experiment aims to study fishing impact using the classic BACI design, Before/After – Control/Impact, and to follow it by monitoring recovery for a minimum of one and a half years. After this period, the results will inform potential ecosystem management strategies, by defining sustainable thresholds regarding habitat and associated species recovery after fishing impact.

The suggested design is mapped in Figure 13. The design has been thoroughly thought through to replicate what could happen on a fishing ground and to allow scientists to quantitatively understand mechanisms of impact and recovery. It also takes account of the fishing practices of the scallopers' fleets. The range of fishing intensities covered in the experiment corresponds to the range of fishing intensities observed on scallop grounds around the Isle of Man. However, it has to be stressed that the present design could be modified at a later stage to account for the outcomes of the appropriate assessment and to accommodate for logistical issues, which will be discussed with the skippers entering the experimental fishery. The aim of the present description is to present the overall design of the experiment and give an estimation of the impact of the experiment in terms of number of square kilometres to be fished as well as fishing intensities to be applied.

Description and preliminary calculations of fishing effort needed for the experiment

As shown in Figure 13, the experiment is composed of 3 replicates (lanes) of 5 different fishing intensities (see 5 squares along each lane in Figure 13). To achieve this, fishing vessels will be given the coordinates of the boxes they have to fish in and they will be asked to fish for a certain number of hours at a certain speed (or to cover a certain distance) within those. Each lane is ca. 1.5km wide by 8km long, or 0.81nm by 4.3nm and each square within the lanes is 1.5km wide by 1.6km long, or 0.81nm by 0.86nm. The total area impacted will therefore be 36km^2, each square being 2.4km^2. This corresponds to 3.75% of the total Cardigan Bay SAC.

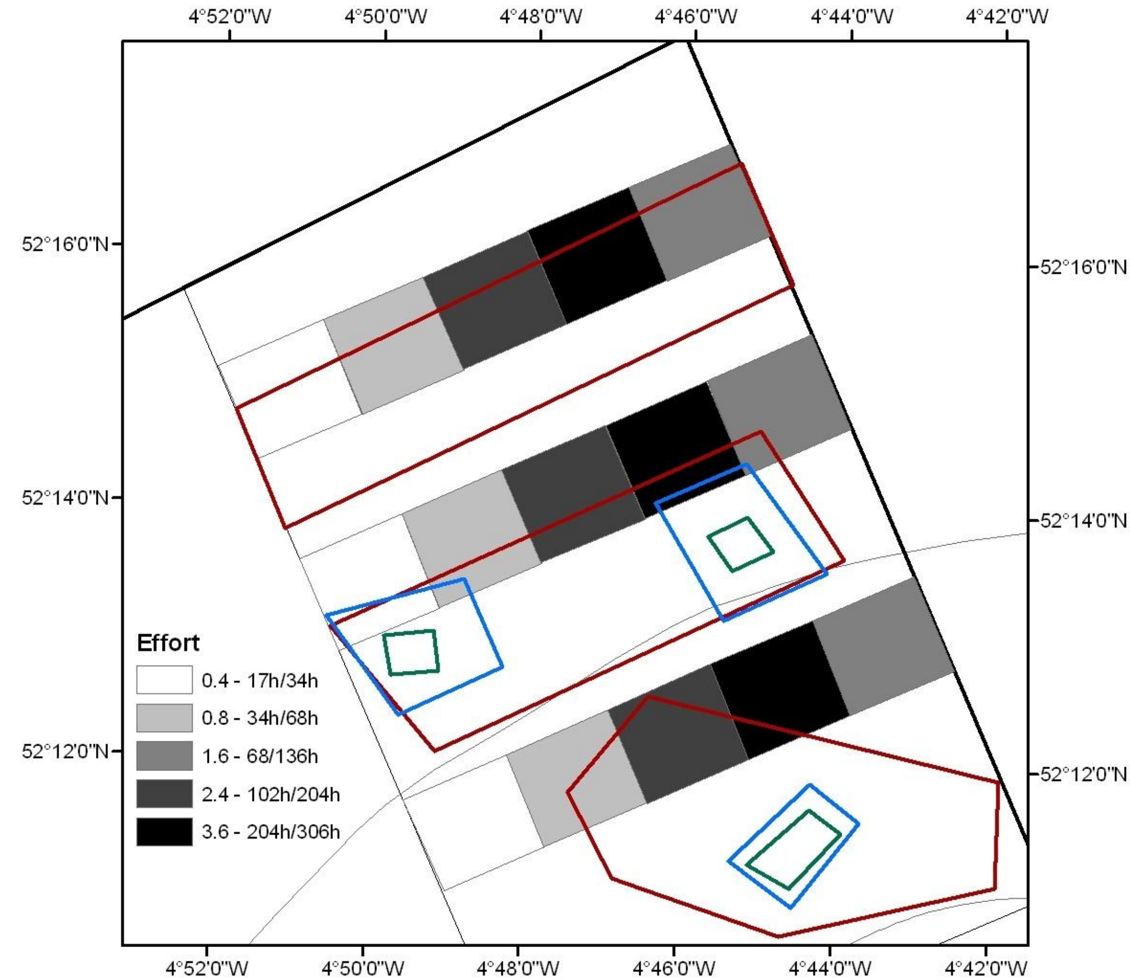

Figure 13. Proposed experimental design. The effort scale is translated in number of hours fished based on vessels with 7 dredges a-side and fishing at 3kn / vessels with 4 dredges aside fishing at 2.5kn. The side scan areas have been overlaid (see Figure 7 for legend).

Since the squares are too small for vessels to efficiently dredge across (1.6km or 0.86nm long), each participating fishing vessel will be asked to fish across 2 squares along the east-west axis. This way, the tows can be 1.72nm long, which corresponds to 41minute tows at 2.5kn or 35minute tows at 3kn. The range of fishing intensities to cover is 0.4 to 3.6. This means that the least impacted area will be fished at 40%, i.e. 40% of the area would be impacted at most if the tracks were not overlapping, while the most impacted area will be fished 3.6 times.

Taking account of these intensities, the total number of square kilometers to fish will be 63.5 km^2 (most of which will overlap since the total area is 36km^2). This can be translated into dredge-hours, i.e. number of hours a single dredge would have to be towed for to complete the experiment. If we assume that a dredge is towed at 2.5kn and is 0.76m wide, then one dredge impacts 0.0035km^2 in an hour. Therefore, it requires 17952 hours of towing. For a 4 dredges a-side vessel, this is equivalent to 2244 hours of dredging. If there were 5 vessels per lane (which might be too much within a 1.5km wide corridor), 15 vessels in total, the number of fishing hours per vessel would be about 150h. If we assume that a dredge is towed at 3kn and is 0.76m wide, then one dredge impacts 0.0042km^2 in an hour. Therefore, it requires 15708 hours of towing. For a 7 dredges a-side vessel, this is equivalent to 1122hours of dredging. If there were 3 vessels per lane, 9 vessels in total, the number of fishing hours per vessel would be about 125h. This is illustrated in Figure 14.

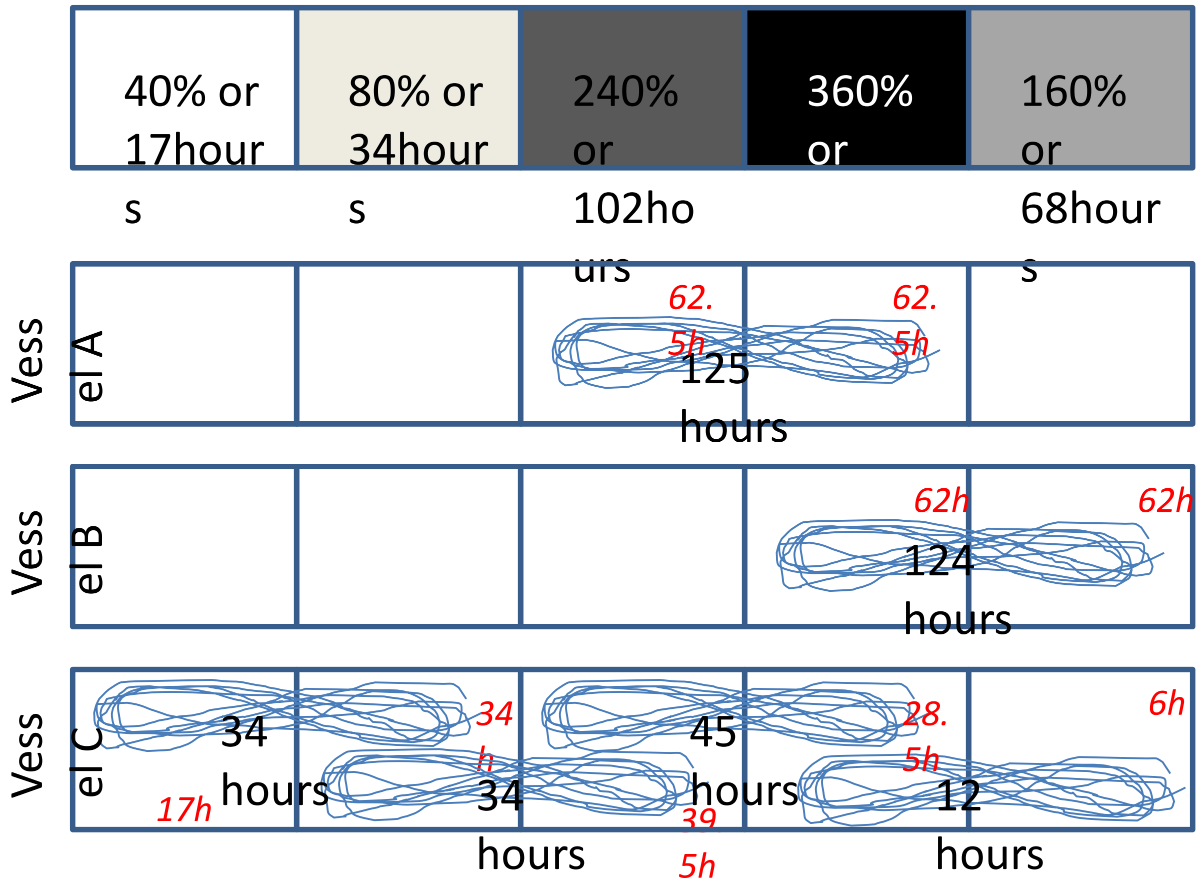

Figure 14. Schematic explanation of fishing intensity experimental design. The top line is the lane to be fished at different intensities. The 3 lines below show where and how much the vessels would have to fish on that top lane. Here the example uses 3 vessels fishing with 7 dredges aside at 3knots but the same principles would apply for smaller vessels or at lower speed, only the number of vessels or dredge-hours per vessel would increase. Here vessel A fishes for 125hours, vessel B for 124hours and vessel C for 125hours.

It has to be noted that the above calculations based on speed, number of dredges aside and number of vessels are only indicative. It is not the purpose of the present report to determine the specifications of the experiment. The objective here is solely to give an estimate of the level of impact on the seabed required for the experiment in order to inform the appropriate assessment while explaining the principles of the experimental design. It is possible that the lanes will be moved further south compared to what is presented in Figure 13. This will depend on the specifications of the dispensations and whether or not larger vessels will be allowed to fish within 6nm. To summarise, the impact on the seabed would cover an area of 36km^2, i.e. 12km^2 per replicate. The intensities would vary, 0.4, 0.8, 1.6, 2.4 and 3.6, and would be applied in squares of approximately 2.4km^2.

Scientific sampling surveys

Sampling will be conducted in each of the 2.4km^2 fished areas and in some control areas around those using grabs, beam trawls and video sleds. There will be a 2 week survey just before the experiment and another one directly after. There will also be further surveys during the following 2 years. The sampling effort and design will be examined in another report.

Discussion

The side scan and ground-truthing images showed that the area proposed for the experiment is dominated by mixed habitats, predominantly composed of sand and gravel but also of patches of cobbles and boulders. All data collected support existing maps of the area (source NRW, Digimap and other). There is no evidence of the existence of dense, stable and resilient stony patches supporting rich epifaunal communities.

Hinz et al. (2010a) found that, in the open area of the Cardigan Bay SAC, interspersed between fields of sand waves rougher ground with boulders casting distinct acoustic shadows were apparent and suggested that the area may consist of an underlying cobble and boulder habitat covered by highly mobile sand. The present report backs up this assumption, with evidence of the presence of sand waves and stony patches in places, although there appeared to be more gravelly grounds in the proposed experimental area than in the open area.

More details on epifaunal biota are given by Hinz et al (2010b). In summary, Hinz et al. (2010b) found that gravel dominated habitats in the western part of the SAC were characterized by the brittlestars *Ophiura albida* (*Ophiotrix fragilis* at some sites) and Hydrozoan species including *Nemertesia* spp. Other species that were also common were small colonies of dead man's fingers *Alcyonium digitatum*, emergent Bryozoan colonies such as *Cellaria* and the star fish *Asterias rubens*. Richer communities of hard substrata species were found between 1.5 and 3nm, supporting the assumption of the existence of stony reefs further inshore, outside the proposed experimental area.

The proposed experiment should therefore not affect any protected feature and the fauna may be expected to be fairly resilient due to high levels of natural disturbance (Sciberras et al. 2013). The range of effort tested should help to answer this question and offer some alternative management strategies with respect to the wider environment and for the scallop fishery, which is now highly concentrated on a small area in a potentially unsustainable manner for the fishery and for seabed habitats and associated species, which may not be able to recover in the short term.

References

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